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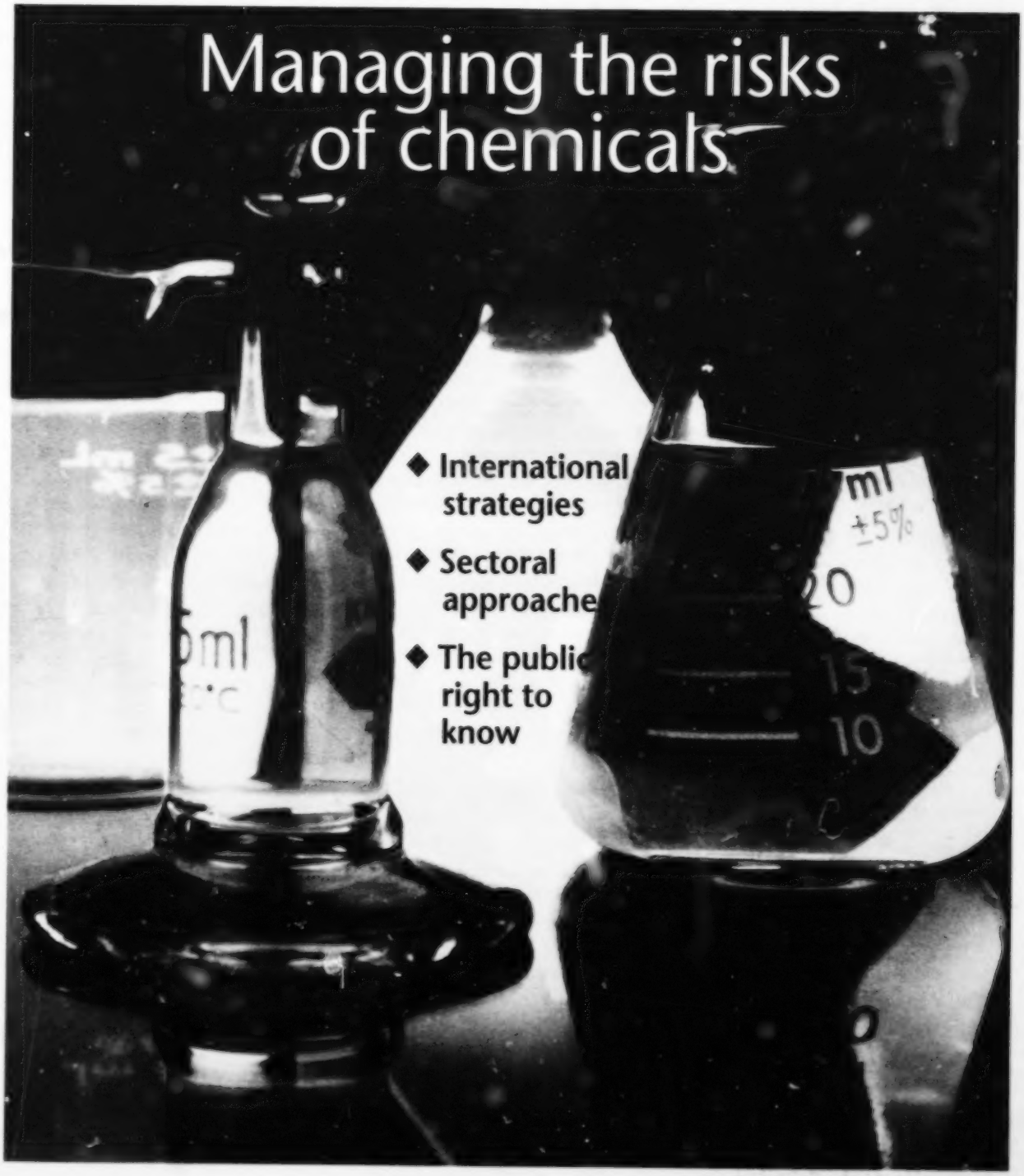

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Contents

Managing the risks of chemicals

3 Editorial: Balancing the benefits of chemicals with their health and environmental risks.

4 The chemical industry and international cooperation to manage chemical risks: facts and figures

7 Global strategy on chemicals management: opportunities and risks – *by Rainer Koch*

9 The Rotterdam Convention: why is it here and what is it trying to achieve? – *by William Murray and Sheila Logan*

12 A science-based strategy for chemicals control – *by Sven Ove Hansson and Christina Rudén*

16 The precautionary principle and EU chemicals policy – *by Mary Taylor*

19 Integrated chemical management: dream or reality in the developing world? – *by Laurraine H. Lotter*

23 The Montreal Protocol: lessons for successful international chemicals management

27 The future of pesticide use in world agriculture – *by J.D. Knight*

30 Mexico's success in eliminating chlordane within a regional cooperation framework – *by Mario Yarto*

33 Effects of an environmental tax on pesticides in Mexico – *by Carlos Muñoz Piña and Sara Avila Forcada*

37 The Africa Stockpiles Programme: cleaning up obsolete pesticides; contributing to a healthier future – *by Clifton Curtis and Cynthia Palmer Olsen*

39 The evolution of Canada's approach to minimizing environmental and health risks from mercury – *by Wanda M. A. Hoskin*

43 Cleaner production in the Indian dye and dye intermediate industry: a successful preventive environmental management strategy for waste minimization and resource conservation – *by P.K. Gupta and S. Kalathiyappan*

47 Implementation of Design for the Environment (DFE) in a Mexican chemical group – *by Margarita Ferat*

52 A Danish company's use of Best Available Techniques for waste handling and treatment – *by Vagn S. Christiansen, Lennart Scherman, Per Kjærgaard and Per Andreasen*

56 Shipbreaking and e-waste: the international trade in hazardous waste continues – *by Kevin Stairs*

58 Fighting environmental crime and protecting the environment: UNEP's Green Customs Initiative

62 Safer road transportation of hazardous material in India: TransAPELL in practice – *by Krishan C. Gupta*

65 Transparency and communities' right-to-know: working towards better disaster management through the OECD – *by Marie-Chantal Huet*

Other topics

68 Financial sustainability at a National Cleaner Production Centre: the experience of the Honduras NCPC – *by Mily Cortés Posas and Nonita T. Yap*

72 Developing a consistent approach to estimating greenhouse gas emissions for the petroleum industry – *by Susann Nordrum, Christopher P. Loreti, Mike McMahon and Karin Ritter*

News • Actualités • Actualidades

76 World News

78 Industry Updates

79 UNEP Focus

82 Books and Reports

85 Web Site Highlights

Balancing the benefits of chemicals with their health and environmental risks

The goal of balancing the economic and social benefits of chemicals with their health and environmental risks is easy to understand and agree to. But how to achieve this balance is a highly complex problem – or rather, it requires understanding and solving many complex problems.

Managing the risks of chemicals is interconnected with many other issues, including wastes and pollution, global warming, resource depletion, agriculture, biotechnology, loss of biodiversity, poverty and women's rights.

Wastes (including hazardous wastes), pollution and climate change have received increasing attention in the last two or three decades, even if much remains to be done in industrialized and developing countries.

One of the lessons of the last few decades is that what is good for the environment generally turns out to be good for business. The costs of wasteful processes (e.g. raw materials loss, wasted energy, waste treatment and disposal) are a good argument for improving these processes, and this has happened worldwide. Companies and countries have been working together to find ways to put the concept of cleaner production into practice.

Chemical plants, like other types of factories, are getting cleaner and greener. However, they are still responsible for a large percentage of emissions of pollutants, such as volatile organic chemicals (VOCs).

The chemical industry uses natural resources to make products for almost every industrial sector. Its primary source of raw materials is the petroleum industry. One problem that some far-sighted analysts are looking at is: what will the chemical industry use for raw materials when petroleum resources – which are finite – run out? The evolving field of "green chemistry" may help to answer this question. Green chemistry has been defined by one scientist as "the development of greener technologies to convert new renewable resources into valuable products in a sustainable manner."

Agrochemicals have been subject to a great deal of scrutiny in the last decades. This attention is not disproportionate to their importance. There have been calls for switching to "organic" or chemical-free agricultural production. Some companies and scientists maintain that genetically modified crops can dramatically reduce the amounts of pesticides and other chemicals used in agriculture. Again, the issue is highly complex and there are compelling arguments for proceeding with caution (see the article "The future of pesticide use in world agriculture" in this issue).

The poor, particularly poor women, are uniquely vulnerable to environmentally related health problems. These are often due to exposure to chemicals, especially in developing countries. It is well-documented that hazardous chemicals have been transported to the Arctic, where they are detectable in the milk of breast-feeding mothers. The Stockholm Convention on Persistent Organic Pollutants (POPs), which entered into force in May, seeks to protect human health and the environment from toxic chemicals that remain intact in the environment for long periods and are widely distributed geographically.

Another treaty, the Rotterdam Convention on prior informed consent (PIC), which entered into force in February, will help protect people in chemical-importing countries.

It is difficult to imagine anyone connected with the chemical industry not being an advocate of biodiversity protection. Here, too, there is still much to be learned. International efforts to halt the destruction of animal and plant species have been inadequate up to now. One reason to protect endangered species is that doing so could produce enormous economic benefits.

The chemical industry is not in the business of disseminating products that deliberately harm human health and the environment. Governments and international organizations, working with the industry, are engaged in applying harmonized testing and assessment methods to as many chemicals and chemical products as possible and sharing this information.

The hazards of some chemicals are already well-known. UNEP's Mercury Programme has been established to promote national, regional and global actions to reduce or eliminate the use of mercury and its release in the environment.

Today, partly in response to the public's demand to know more about their safety, vast amounts of information about chemicals are available from universities, regulatory bodies, specialized publications and other sources – much of it on-line. This information can be highly complex and subject to contradictory interpretations (compare, for example, the sites of chemical industry organizations with those of some of the organizations that are sceptical about the industry's good faith).

Since UNEP's proposal for a Strategic Approach to International Chemicals Management (SAICM) was endorsed by the World Summit on Sustainable Development in 2002, efforts have been ongoing to further develop this strategy. SAICM will advance the sound management of chemicals worldwide, building on progress already made in the last 20 to 30 years. ◆

The chemical industry and international cooperation to manage chemical risks: facts and figures

We live in a chemical world. Man-made chemicals are found in almost every product we use or consume. Global chemicals production in 1930 was about 1 million tonnes; today it is something like 400 million tonnes. Global chemicals output last year was estimated at close to US$ 2000 billion.[1]

The 25 EU Member States make up the world's largest single chemicals producing region (34% of total sales in 2003). Two-thirds of global chemical production takes place in Europe and the United States (**Figure 1**). The EU is the leading chemicals exporter and importer, accounting for half of all global trade. The largest chemical trading regions are the EU, Asia and North America.

Between 1998 and 2003, chemicals production grew more strongly in the EU than in either the US or Japan (2.7 % per year, compared with 0.7% and 1.3%, respectively, in those countries) (**Figure 2**). In this period there was very strong growth in the "emerging" countries (e.g. India and China).

Many different manufacturing and processing activities take place in the chemical industry. A very large share of products (up to one-third) continue to be processed within the industry. Consumer products may not be marketed until they have undergone several processing stages.

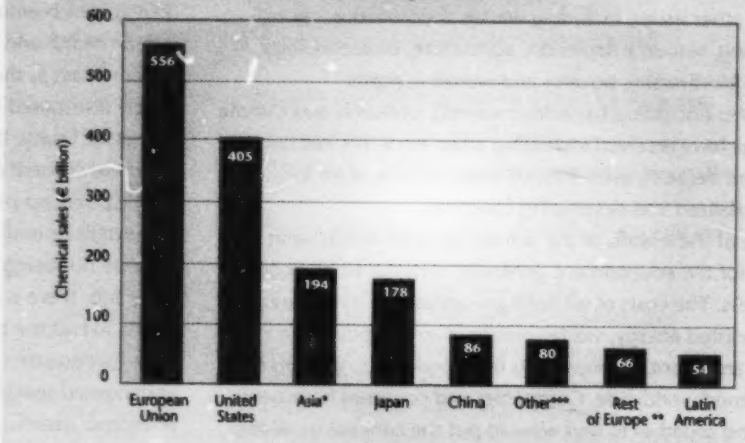
The chemical industry supplies virtually every economic sector (including itself). It "underpins innovation across all industry sectors, ranging from new materials for energy systems, electronics and modern apparel, to life science products needed for food production and medicine," to quote a recent presentation by the head of the Canadian Chemical Producers Association.[2]

Research and development is of basic importance to this industry. The proportion of EU chemical industry sales (excluding pharmaceuticals) devoted to R&D in 2003 was 1.9%, lower than in the United States or Japan. The American Chemistry Council reports that the US chemical industry spends US$ 31 billion per year on research and development and employs 80,000 research scientists, engineers and technicians. One out of every seven patents issued in the US is for a chemical industry invention.

The chemical industry has an enormous impact on employment, trade and economic growth worldwide.[3] Like other industries, it has succeeded in reducing emissions of pollutants (**Figure 3**) and introduced countless other improvements to protect health and the environment, in many cases through its Responsible Care programme (see "Web Site Highlights").

We are accustomed to thinking of the chemical industry as dominated by a few multinationals. But a surprising number of chemical companies (in industrialized as well as developing countries) are small and medium-sized. In the EU chemical industry, SMEs account for 45% of added value and 46% of employment. Only 2% of EU chemical companies employ more than 499 employees, though these companies generate 55% of total added value.

Figure 1
World chemicals production, 2003



Definition: Asia*: excluding Japan and China
Rest of Europe** – Switzerland, Norway, and other Central and Eastern Europe (excluding the accessing countries EU 10)
Other*** including Canada, Mexico, Africa and Oceania

Source: Cefic

Chemical safety

The conservation organization WWF recently cited chemical pollution as one of the two great environmental threats to the planet, along with global warming. WWF is especially concerned about "persistent and accumulative" industrial chemicals and hormone-disrupting substances (endocrine disruptors).

We are continuously reminded that much remains to be done in order to understand and control chemicals. Cancer, birth defects, neurological disorders and other diseases are associated with exposure to certain chemicals. Poisoning is one of the most frequent causes of mortality in hospital patients in some developing countries. Despite significant safety improvements at plants and warehouses (not all of which are part of the chemical industry), and during transport, accidents involving chemicals continue to occur.

Following the Second World War, the number of chemicals and chemical products increased dramatically and concerns began to be expressed about their potentially harmful effects. Pesticides received particular attention. Most pesticides are persistent in the environment, have a tendency to bioaccumulate, and are toxic to animals and plants other than the ones they were designed to eliminate. Especially since the 1960s, there has been growing public support for determining chemicals' hazards and risks and regulating them accordingly.

It has long been evident that health and environmental problems cannot be adequately addressed without a thorough knowledge of the behaviour of the chemicals involved. Today vast amounts of information about chemicals are available, much of it on-line. However, there are tens of thousands of chemicals on the market about which available data are inadequate for even rough estimates of their potential adverse effects to be made (see the articles "A science-based strategy for chemicals control" and "The precautionary principle and EU chemicals policy" in this issue).

Many of these chemicals were placed on the market before modern chemical notification systems were established and are therefore referred to as "existing" chemicals. Efforts are under way in countries and internationally to investigate, on a

priority basis, those existing chemicals which are being manufactured in the largest volumes (called high production volume or HPV chemicals).[4]

International cooperation

In response to the public's insistence that it has a right – and a responsibility – to know the truth about chemicals, many laws, agreements, ministries, agencies, and NGOs and other organizations have been created at the national and international level.

Two types of chemical products, both in use since the 1930s, were the target of early international cooperative efforts: polychlorinated biphenyls (PCBs) and chlorofluorocarbons (CFCs). As long as these substances were considered safe, millions of tonnes of each were produced. Once it was established that they were dangerous, their *production* was rapidly curtailed. Nevertheless, they are still present in the environment.

The first concerted international action to control the risks of a specific chemical was the 1973 Decision by the Council of the Organisation for Economic Co-operation and Development (OECD) to control PCBs.[5] Subsequently, a 1976 EEC Directive banned the use of PCBs except in sealed equipment. In 1979 the US Environmental Protection Agency (EPA) banned their manufacture.

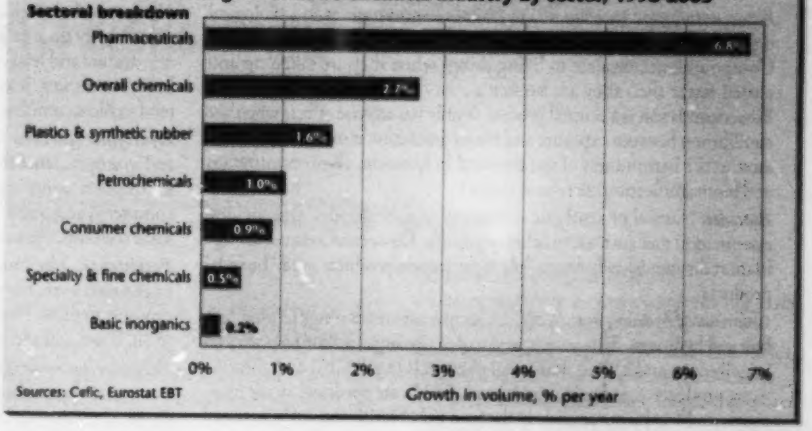
Successful implementation of the Montreal Protocol, which came into force in 1989, has brought about major reductions in the production, consumption and releases of ozone depleting substances, including CFCs (see the article "The Montreal Protocol: lessons for successful international chemicals management").

As laws to protect human heath and the environment became more stringent in industrialized countries, these countries increased their exports of hazardous materials to developing countries and countries with economies in transition. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, adopted in 1989, attempts to control such exports. At the time of its adoption, some 400 million tonnes of hazardous wastes were generated each year, around 75% in industrialized countries. The "Basel Ban" strengthening the Basel Convention was introduced a few years later.

In the decade or so preceding the landmark UN Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, there was considerable emphasis on cooperation in chemicals control by international organizations, governments and major groups. Attention began to be focused on internationally harmonized approaches to testing chemicals' hazards and assessing their risks.

Not long after the Sandoz warehouse fire in Basel in 1986, greater attention also began to be given to international cooperation with respect to prevention, preparation and response to chemical accidents in industrialized and developing countries. UNEP's APELL Programme, the OECD's Chemical Accidents Programme and related activities in the chemical industry, governments and other organizations date from the late 1980s.

Figure 2
Production growth of EU chemical industry by sector, 1998-2003



Sources: Cefic, Eurostat EBT

The UN Conference on Environment and Development (UNCED) and beyond

The Rio Declaration and Agenda 21 (UNCED's comprehensive "action programme" for the 21st century), both agreed in 1992, supported the international activities then being carried out and called for these activities to be strengthened. The achievements of international organizations in the chemicals risk management area since 1992 largely respond to these two agreements, especially Chapter 19 of Agenda 21, "Environmentally Sound Management of Toxic Chemicals including Prevention of Illegal International Traffic in Toxic and Dangerous Products."[6]

Among its recommendations, Chapter 19 called for a harmonized hazard classification and labelling system to be established by the year 2000 to make the handling and use of chemicals safer. Work on the new Globally Harmonised System for the Classification and Labelling of Hazardous Chemicals (GHS) – by individuals, governments, international organizations and others – has been coordinated and managed under the auspices of the Inter-organization Programme for the Sound Management of Chemicals (IOMC).[7]

Under the Johannesburg Plan of Implementation, countries should implement the GHS as soon as possible, with a view to the system being fully operational by 2008. Plans for worldwide implementation include activities to help developing countries that lack the infrastructure to implement the GHS.

Three international conventions, developed in the last two decades, provide an international framework for environmentally sound management of hazardous chemicals throughout their life cycles: the Rotterdam Convention on Prior Informed Consent (PIC) (adopted 1998, entered into force 2004), the Stockholm Convention on Persistent Organic Pollutants (POPs) (adopted 2001, entered into force 2004) and the 1989 Basel Convention.

Chemical accidents: six important dates

1989: The supertanker *Exxon Valdez* runs aground in Alaska, dumping 10 million gallons of crude oil into the ocean and causing extensive damage to the Prince William Sound ecosystem. One of a series of tanker wrecks that increased public awareness of the lack of environmental protection measures by the oil industry – and of the fact that oil spills are not even the major cause of oil pollution of the sea. Most oil pollution is not accidental, and much of it comes from land-based sources.

1986: Sandoz warehouse fire in Basel, Switzerland, during which more than 30 tonnes of pesticides, fungicides and chemical dyes were washed into the Rhine, draws attention to other (unreported and under-reported) incidents involving pollution of the Rhine by chemical companies.

1984: Release of methyl isocyanate (MCI), a toxic gas used in manufacturing pesticides, at a chemical plant at Bhopal, India, heightens concern about safety in and around industrial installations, especially in developing countries.

1976: Release of toxic cloud from a chemical plant in Seveso, Italy, increases public awareness of dioxins (as did designation of the Love Canal area, near Niagara Falls in the United States, as a disaster area in 1978).

(It is generally agreed that the consequences of the Basel and Seveso accidents could have been very much worse.)

In addition, the nuclear accidents at Three Mile Island in the United States (1979) and Chernobyl in Ukraine (1986) were powerful reminders that "pollution is no respecter of borders" (the pollution in this case was radioactive particles) and that accurate information needs to be disseminated to potentially affected populations.

Definitions

Bioaccumulation: Increase in a chemical's concentrations in a biological organism over time, compared to its concentrations in the environment. Compounds accumulate in living things when they are taken up and stored faster than they are broken down (metabolized) or excreted. Bioaccumulation is a normal process. It only has adverse effects when the equilibrium between exposure and bioaccumulation is overwhelmed, relative to the harmfulness of the chemical in question. (Bioconcentration and biomagnification are related terms.)

Biocides: Natural or synthetic substances (e.g. herbicides, insecticides, rotenticides) that are toxic to other organisms. European Community legislation distinguishes between "plant protection products" and "biocidal products".

Chlorinated hydrocarbons (CHCs): Compounds containing chlorine, carbon and hydrogen. This term is used to describe organochlorine pesticides (e.g. lindane and DDT), industrial chemicals (e.g. PCBs) and chlorine waste products (e.g. dioxins and furans). CHCs are persistent in the environment. Most bioaccumulate in the food web. Health and environmental effects depend on individual compounds.

Dioxins: Toxic, probably carcinogenic family of chemicals. Persistent and bioaccumulated, they are widely distributed in the environment. Many people have detectable levels of dioxins in their tissues.

Endocrine disruptors: Chemicals that can disrupt endocrine systems, causing developmental and reproductive problems. There are concerns that endocrine disruptors in the environment threaten the health of humans and wildlife.

Heavy metals: Metallic elements that have relatively high density and are toxic, highly toxic or poisonous at low concentrations. Mercury, cadmium, arsenic and lead are examples. Apart from the toxicity of individual heavy metals (e.g. lead is a neurotoxin), they are dangerous because they tend to bioaccumulate.

Hydrofluorocarbons (HFCs): Compounds containing fluorine, carbon and hydrogen. Since they do not contain chlorine and do not directly affect stratospheric ozone, certain chemicals within this class of compounds are considered acceptable alternatives to CFCs and HCFCs by industry and some scientists. However, HFCs have other adverse environmental effects.

Persistence: The longer chemicals persist in the environment in an unchanged form, the greater the potential is for human or environmental exposure to them. Persistence is usually measured or estimated with respect to air, water, soil and sediment.

Polychlorinated biphenyls (PCBs): Toxic, possibly carcinogenic compounds used as coolants and lubricants. PCBs are not readily broken down in the environment. In countries where they have been banned, they continue to be released to air, water and soil. PCBs can only be destroyed in special incinerators at extremely high temperatures.

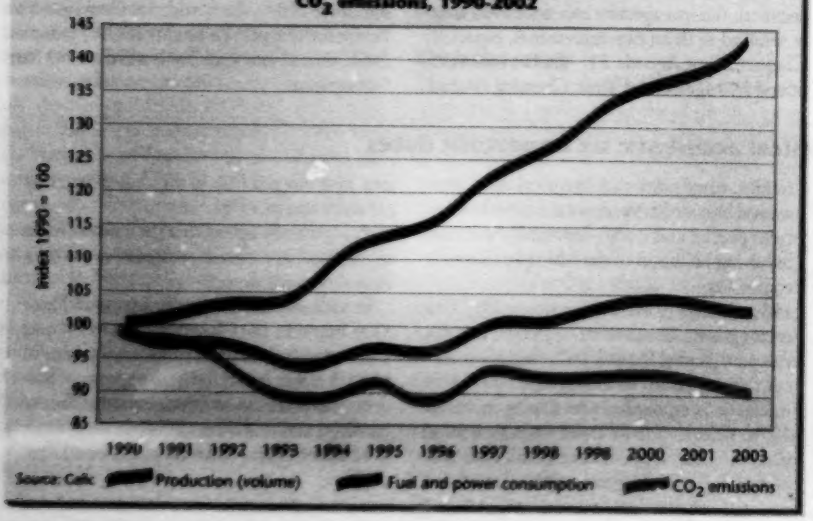
Persistent organic pollutants (POPs): Substances that persist in the environment, bioaccumulate through the food web and present a risk of adverse effects to human health and the environment. There is evidence of long-range transport of these substances to regions where they have never been used or produced.

Stable: Not easily decomposed or otherwise chemically modified.

At the regional level, this year is the 25th anniversary of the Geneva Convention on Long-range Transboundary Air Pollution of the UN Economic Council of Europe (UNECE). The UNECE's more recent Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (adopted 1998, entered into force 2001) establishes links between human rights and "environmental rights".[8]

UNEP's proposal for a new Strategic Approach to International Chemicals Management, currently being developed in cooperation with other international organizations, builds on this international cooperative work. The World Summit on Sustainable Development in 2002 supported the development of SAICM as a next step towards effective worldwide chemicals management.

Figure 3
EU chemical industry production, energy consumption and CO_2 emissions, 1990-2002



Notes

1. A great deal of information is available about chemicals and the chemical industry. Among many other sources, see the web sites of the European Chemical Industry Council (www.cefic.be) and the American Chemistry Council (www.americanchemistry.com), both of which were used in the preparation of this article.
2. Richard Paton, "Industry Prospects for Growth, Investment, and Recovery," Canadian Research Institute (CERI) Petrochemical Conference, 7 June 2004 (www.ccpa.ca/News/news06070403.aspx).
3. The effect of chemical regulation on trade is an important issue for the industry.
4. See, for example, EU Environment Commissioner Margot Wallström's speech to the 2nd EU-US Chemicals Conference, Charlottesville, Virginia, 27 April 2004 (www.eurunion.org/news/press/2004/20040064.htm). Also see "Description of OECD Work on Investigation of High Production Volume Chemicals" (www.oecd.org/ehs).
5. OECD countries account for about three-quarters of global chemical production. The member countries are Australia, Austria, Belgium, Canada, the Czech Republic, Demark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. For information about the OECD's Environment, Health and Safety Programme, see www.oecd.org/ehs.
6. www.unep.org/documents/default.asp?documentID=52&articleID=67.
7. The Inter-organization Programme for the Sound Management of Chemicals (IOMC) helps coordinate the work of seven intergovernmental organizations.
8. UNECE has negotiated five environmental treaties, all of which are in force (www.unece.org/env/lrtap). Environmental treaties have also been agreed in other regions. ◆

Global strategy on chemicals management: opportunities and risks

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Summary

A Strategic Approach to International Chemicals Management (SAICM), growing out of previous international activities related to chemicals safety, has received the support of UNEP's Governing Council. The global chemical industry considers that SAICM should be treated as a road map for achieving goals agreed at the World Summit on Sustainable Development. Continuous global improvement in the safe use of chemicals will require joint, coordinated activities by producers, distributors, users, governments and other stakeholders, based on shared responsibility at every relevant stage of the product chain. In this respect, the development of a global strategy provides an opportunity to build a new partnership approach to chemical safety. If SAICM were the basis for additional stringent regulatory approaches at the national, regional or international levels, however, it might not have the desired impact.

Résumé

L'approche stratégique de la gestion internationale des produits chimiques (SAICM), fruit d'activités internationales antérieures dans le domaine de la sécurité chimique, a reçu le soutien du Conseil d'administration du PNUE. Pour l'industrie chimique mondiale, la SAICM doit être considérée comme une voie à suivre pour atteindre les objectifs fixés lors du Sommet mondial pour le développement durable. Pour que l'usage des produits chimiques devienne de plus en plus sûr sur toute la planète, il faut une action conjointe et coordonnée des fabricants, des distributeurs, des utilisateurs, des gouvernements et des autres parties concernées, fondée sur le principe d'une responsabilité partagée à tous les niveaux de la chaîne de production. De ce point de vue, l'élaboration d'une stratégie mondiale est l'occasion d'adopter une nouvelle approche de la sécurité chimique fondée sur des partenariats. Par contre, si la SAICM devient un prétexte pour renforcer la réglementation et la rendre plus drastique au niveau national, régional ou international, elle risque de ne pas avoir l'effet voulu.

Resumen

El Consejo de Administración del PNUMA ha otorgado apoyo a un enfoque estratégico para la gestión internacional de sustancias químicas (SAICM), derivado de actividades previas vinculadas a la seguridad en el manejo de sustancias químicas. La industria química mundial considera que el SAICM debe adoptarse como guía hacia el cumplimiento de los objetivos convenidos durante la Cumbre Mundial sobre Desarrollo Sostenible. La mejora continua en el uso inocuo de las sustancias químicas exigirá la coordinación de actividades conjuntas por parte de los productores, distribuidores, usuarios, gobiernos y otras partes interesadas a partir de su responsabilidad compartida en cada etapa importante de la cadena del producto. En este sentido, la formulación de una estrategia mundial constituye la oportunidad de crear un nuevo enfoque de formación de alianzas orientadas a la seguridad en el manejo de las sustancias químicas. No obstante, en caso de que el SAICM fuera tomado como base para la formulación de otros enfoques normativos más rigurosos en la escala nacional, regional o internacional, podría perderse el impacto deseado.

Chemicals management means ensuring the safe use and handling of chemicals along the product chain. While chemicals management has been practised by the chemical industry for many decades, it has not always been visible to (or noticed by) the general public. The tools and techniques applied in managing chemicals have become increasingly sophisticated over time. However, there is still a need for improvement along the product chain and at global level. The basic principle of chemicals management has been, and remains, that it should be based on the potential risk that chemicals could pose to health and the environment if they are not handled safely. This principle has its roots in a concept established by the Renaissance physician Paracelsus: "The dose alone makes the poison."

Public scepticism about chemicals management has grown in recent years, culminating in the fear that "nobody knows how many chemicals are on the market, and even worse nobody knows how many of these are toxic chemicals." This situation (especially regarding the public's perceptions) has led to some easily observable consequences:

- a permanent decrease in public confidence in the chemical industry;
- a continuous increase in the number of regulatory systems related to chemicals management at the national and regional levels;
- a call to regard the precautionary principle as the key to chemicals management;
- the search for "natural" chemicals (i.e. "safer" products) as substitutes for synthetic ones.

The chemical industry is no longer confronted with national or regional legislation only. Since the 1992 UN Conference on Environment and Development (UNCED) there has been a clear tendency for intergovernmental organizations and national governments to regulate hazardous chemicals and products globally by developing international treaties (e.g. the Basel Convention on Hazardous Wastes,[1] the Stockholm Convention on Persistent Organic Pollutants[2] and the Rotterdam Convention on Prior Informed Consent[3]). On 15 February 2002, at its seventh Special Session/Global Ministerial Environment Forum in Cartagena, Colombia, UNEP's Governing Council decided that there is a need to further develop a *Strategic Approach to International Chemicals Management (SAICM)*.[4] The International Forum on Chemical Safety (IFCS) Bahia Declaration and its Priorities for Action beyond 2000[5] were endorsed as the foundations of this approach.

At its 22nd Session on 3-5 February 2003,[6] the Governing Council recalled the Cartagena decisions and the decisions of the World Summit on Sustainable Development (WSSD) in Johannesburg and decided to proceed with the development of the SAICM – with a view to contributing to sustainable consumption and production, and as part of the overarching goal of supporting sustainable development. This decision also calls for the process to be "open, transparent and inclusive, providing all stakeholders opportunities to participate."

A first SAICM Preparatory Committee (PrepCom) meeting took place in Bangkok on 9-13 November 2003.[7] A second PrepCom meeting is scheduled in Nairobi on 4-8 October of this year.[8]

SAICM and the chemicals industry perspective

The global chemical industry supports, as an overarching goal of SAICM, what was agreed upon in paragraph 23 of the WSSD Plan of Implementation in Johannesburg in 2002.[9] SAICM should be considered a road map for achieving that goal. Continuous improvement globally in the safe use of chemicals will require joint, coordinated activities among producers, distributors, users, governments and other stakeholders, based on shared responsibility at each relevant stage of the product

chain. In this respect, the development of a global strategy provides an opportunity to build a new partnership approach to chemical safety.

A high level of cooperation on global chemical issues has already been achieved between producers and governments, notably in the Rotterdam and Stockholm Conventions and the High Production Volume (HPV) Chemicals Initiative of the International Council of Chemical Associations (ICCA).[10] Further enhancement of cooperation among all stakeholders is needed in order to bridge the gap in chemicals management between developed and developing countries, as one of the key goals of the strategy. It is important in this context to note that the UNEP GC/GMEF recently decided that there is a need to prepare an intergovernmental strategic plan for technology support and capacity building.[11]

Governments, NGOs and industry are involved in a political process aimed at developing a strategic framework that consists of principles, elements and concrete measures concerned with safe production, use and disposal of chemicals and chemical products across the product chain at the global level.

This strategy, which will be embedded in the overall issue of sustainable consumption and production, will contribute to sustainable development. It should be recognized that not only will the strategy have impacts on the chemical industry's business, but it will also have much broader consequences affecting other industries, our customers and (directly or indirectly) the final consumer. These impacts may be social or environmental as well as economic in nature.

Development of the strategy will clearly be influenced by national/regional chemical policies, trade and economic aspects, environmental and health policies, agriculture and industry policy, and (in principle) countries' general public policy.

Opportunities

The chemical industry sees the strategic approach as an excellent opportunity to improve public confidence in the safe and environmentally sound management of chemicals, and to further promote the benefits of chemistry to the global society.

From the chemical industry perspective, it is key that the strategy provides the means to bridge the gap in chemicals management between developed and developing countries. It is a prerequisite that chemicals policy will become a building block of a more general public policy. The strategy should build on the obligations and responsibilities for safe use of chemicals that are shared by producers, distributors, users and governments and are obtained as a result of a new partnership approach towards chemical safety. This approach should involve all stakeholders (particularly governments, business and representatives of civil society), keeping in mind the need to reduce or eliminate the differences between developed and developing countries as agreed at the WSSD.

Capacity building (in the sense of building infrastructure, and promoting and supporting education and training for using cleaner technologies and handling chemicals safely) should therefore be a key element of this strategy.

A global strategy should be integrative. To ensure efficiency, consistency and coherence in the basic concepts required for regulatory approaches, it should provide mechanisms for the improvement of internal and external coordination at the governmental and intergovernmental levels. It should also enhance synergies and cooperation among relevant international and regional treaties, secretariats and agencies.

SAICM could provide the opportunity to remove trade barriers, so as to reduce and (further) avoid unnecessary costs and bureaucracy, streamline regulatory approaches, promote voluntary activities, and provide public access to information on the safe management of chemicals and processes, while protecting legitimate corporate interests in technical or commercial information.

The strategy should encourage the development of efficient and transparent mechanisms and a policy framework for sharing best practices among companies in the global product chain, as well as among governments. It should provide the means to eliminate unnecessary barriers to innovation, and to set up conditions to ensure that industry can share best practices and use cleaner and (whenever possible) best available technologies and innovative products for the benefit of the global society.

The strategy should be the basis for a consistent global approach, to be implemented regionally and/or nationally in ways that support innovation, avoid duplication, and maximize sharing of knowledge and the use of synergies. Implementation in specific regions and countries should consider the differences in national or regional regulatory approaches and in societal, economic and political conditions. In line with this vision, the chemical industry has actively contributed (with governments and other stakeholders) to the development of regulations and is publicly engaged in providing its technical expertise to ensure better chemicals management at the local level.

Risks

However, there are also threats on the horizon. This strategy framework could be the basis for additional, even more stringent, legally binding regulatory approaches at the national, regional or international levels, which would not always contribute to more effective chemical safety. Differences in societal, economic, cultural and political conditions at the national/regional level may lead to greater divergence in the implementation of regulatory systems, resulting in contradictory measures. This would widen even further the gap between developed and developing countries in terms of safe chemicals management and have a negative impact in respect to WTO free trade rules. Taking into account the importance of the chemical business globally, the consequences could affect the living conditions of large populations, notably those most in need.

It is also obvious that the call for a life-cycle assessment approach and its implementation will impact on downstream users of chemicals, especially small and medium-sized enterprises. These businesses, whether they are located in developed or developing countries, are generally not well prepared technically or economically to respond to complex demands such as those related to life-cycle assessments.

Last but not least, regulatory approaches based on this strategy could have an impact on the innovation and competitiveness of the chemical industry and other industry sectors if unbalanced or one-sided regulations come into force, imposing unnecessary obstacles along the value chain.

Conclusion

Despite the present lack of a clear picture in respect to SAICM, the global chemical industry perceives in this process a chance for a balanced outcome, levering the need for command and control systems with a sound, flexible and practical strategic approach that will promote and support industry's stewardship of chemicals, and one that is aimed at more regulatory efficiency, integration, coherence and consistency, less bureaucracy, and the strengthening of industry voluntary activities and cooperation among all stakeholders in a new partnership. Implementation of the Globally Harmonized System of Classification and Labelling (GHS)[12] is a good example of an active contribution to capacity building by the chemical industry, jointly with governments and intergovernmental organizations (e.g. UNITAR[13]), and a step forward towards chemical safety globally.

Notes

1. www.basel.int.
2. www.pops.int.
3. www.pic.int.
4. www.unep.org/governingbodies/governing-council_seventh.asp; www.chem.unep.ch/saicm.
5. www.who.int/ifcs/Documents/ Forum/ ForumIII/f3-finrepdoc/Bahia.pdf.
6. www.unep.org/GC/GC22.
7. www.chem.unep.ch/saicm/prepcom1.
8. www.chem.unep.ch/saicm/prepcom2.
9. www.un.org/esa/sustdev/documents/ WSSD_ POI_PD/English/WSSD_PlanImpl.pdf.
10. www.icca-chem.org/section02b.html.
11. www.unep.org/DPDL/cso/Documents/ K0471247_decision_SS-VIII-1.doc.
12. www.unece.org/trans/danger/publi/ghs/officialtext.html.
13. http://www.unitar.org/cwm/pag/ghstrain.html.

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The Rotterdam Convention: why is it here and what is it trying to achieve?

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The 20th century saw a dramatic increase in the use of a range of synthetic chemicals, particularly in manufacturing industries and in agriculture. Many of these chemicals were later shown to have a range of undesirable characteristics, including persistence in the environment, a tendency to biomagnify in the food chain, and negative effects on the environment. Some chemicals were also shown to cause cancer or birth defects. Others were very hazardous even after a very limited exposure.

In the 1970s and 1980s there were concerns that actions taken in some countries to ban or restrict the use of certain chemicals for effects such as these could result in the chemicals being exported to other countries where regulatory systems, infrastructure and resources were sometimes not adequate to manage their risks.

In response to these concerns, the FAO developed the voluntary *International Code of Conduct on the Distribution and Use of Pesticides* (the Code). The Code was adopted in 1985. It was amended in 1989 and again in November 2001 to reflect changing trends in pest and pesticide management. In parallel with these initiatives, UNEP developed the London Guidelines for the Exchange of Information on Chemicals in International Trade to assist countries in managing risks associated with industrial chemicals.

Both the FAO Code of Conduct and the London Guidelines were amended in 1989 to address issues related to the export of chemicals (including pesticides) from a country that had banned these chemicals. At that time, the governing bodies of FAO and UNEP agreed to work cooperatively. In 1992 they implemented a joint programme on the Prior Informed Consent (PIC) Procedure.

The United Nations Conference on Environment and Development (UNCED) recommended in 1992 that the PIC procedure be further developed into a legally binding instrument by 2000 (Agenda 21, Chapter 19, paragraph 19.39d). Following this recommendation, the FAO Council and the Governing Council of UNEP authorized the convening of an Intergovernmental Negotiating Committee (INC). Its mandate was to prepare an international legally binding instrument for the application of the PIC procedure to certain hazardous chemicals and pesticides in international trade.

Commencing in March 1996, UNEP and FAO convened five meetings of the Intergovernmental Negotiating Committee. Governments, intergovernmental organizations and NGOs attended the negotiating sessions. The fifth and final negotiating session was held in Brussels, Belgium, on 9-14 March 1998. The text of the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade was adopted on 10 September 1998 in Rotterdam, The Netherlands. This was two years ahead of the target set by UNCED.

In recognition of the importance of the Convention, it was agreed by the Conference of Plenipotentiaries that the voluntary PIC procedure should continue to operate pending the entry into force of the Convention. The Conference therefore adopted a resolution on interim arrangements to bring the original PIC procedure into line with the provisions in the Convention. The Convention entered into force on 24 February 2004. The first meeting of the Conference of the Parties (CoP) was convened for September 2004.

The Convention's two main provisions: information exchange and the PIC procedure

The overall objective of the Convention is to promote shared responsibility and cooperative efforts among Parties with respect to the international trade of certain hazardous chemicals, in order to protect human health and the environment from potential harm and to contribute to environmentally sound use of these chemicals. There are two key provisions: information exchange and the PIC procedure. Information exchange applies to any chemical banned or severely restricted by a Party. The PIC procedure applies to chemicals listed in Annex III of the Convention. For these chemicals, countries are invited to take an informed decision regarding their future import. Exporting Parties are obliged to respect these decisions.

The Rotterdam Convention is not designed to ban or eliminate the use of chemicals at the international level, but rather to provide countries with a means to assess the risks associated with included chemicals and make an informed decision about whether they will allow future imports of chemicals subject to the PIC procedure and therefore listed in Annex III of the Convention.

At present, 27 chemicals are listed in Annex III of the Convention. These are both pesticides and industrial chemicals. Chemicals can be subject to the PIC procedure and listed in Annex III following their ban or severe restriction in two countries from two regions, or on the basis of advice from a developing country that a specific formulation is causing health or environmental problems under normal conditions of use within that country. During the interim arrangements mentioned above, a further 11 chemicals were identified, with another four chemicals scheduled to be considered at the last meeting of the Intergovernmental Negotiating Committee in September 2004. The first meeting of the CoP will decide whether these chemicals (which it was agreed would be made subject to the interim PIC procedure) should be added to Annex III of the Convention.

The recommendation to include these chemicals in the interim PIC procedure was based on a review by the Interim Chemical Review Committee, a subsidiary body of the Intergovernmental Negotiating Committee. The Interim Chemical Review Committee examined chemicals if at least two notifications of final regulatory actions to ban or severely restrict them had been received from at least two regions. The Committee looked at the notifications and determined whether they met the Convention's criteria for listing. Where this was the case, the Committee started to prepare a decision guidance document. In a number of cases the notifications did not meet the criteria set out in Annex II (which contains criteria for consideration by the Chemical Review Committee), often because one or both of the notifications had not been based on a risk evaluation. In these cases, the Interim Chemical Review Committee recommended that the chemical not be included at this stage.

To facilitate its work, the Interim Chemical Review Committee also prepared a range of policy and guidance documents that clarified how the work of the Committee had been carried out, with the aim of ensuring consistency and establishing a basis for future similar decisions. They also oversaw the development of a guidance document and forms for indicating health or environmental problems with severely hazardous pesticides. In addition, they developed guidance for groups developing decision guidance documents to ensure consistent content and formatting.

The INC has facilitated a series of workshops held around the world, primarily to train designated national authorities in the working of the Convention. These workshops have been organized by the secretariat on a regional or sub-regional basis. Eight regional training workshops have been held for Latin America and the Caribbean (English-speaking countries) in May 2002; Africa (French-speaking countries) in June 2002; the Near East in October 2002; Central and Eastern Europe in November 2002; Africa (English-speaking countries) in February 2003; the South-West Pacific in September 2003; Latin America and the Caribbean

continued on page 10

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(Spanish-speaking countries) in October 2003; and the Asia region in March 2004.

Workshops have therefore been held in Arabic, English, French, Spanish and Russian. While the prime focus of the workshops has been on training designated national authorities in the main tasks required to meet the Convention's obligations (e.g. submitting import responses, notifying bans or severe restrictions on chemicals), a number of other issues have been addressed, such as opportunities for coordinated implementation for the Rotterdam, Stockholm and Basel Conventions, the use of integrated pest management, and opportunities for regional cooperation. The workshops have included participation by a range of representatives, including from the Basel Regional Centres, industry and NGOs. Participants have generally agreed that the workshops were valuable as a training mechanism and as a way to meet and get to know other people in the region with similar tasks and responsibilities.

The INC has worked with the World Customs Organization (WCO) on the development of specific codes to be used for the chemicals included in the Rotterdam Convention. These codes, developed by the expert bodies of the WCO, will be considered for inclusion in June this year. Further work with the WCO will continue.

Following a decision taken by the UNEP Governing Council to promote synergies between related multilateral environmental agreements (MEAs), the secretariat of the Rotterdam Convention has been pleased to assist this process in cooperation with other secretariats, particularly those of the Stockholm and Basel Conventions. A number of regional and sub-regional workshops have been held to present ideas and facilitate discussion concerning the coordinated implementation of the Basel, Stockholm and Rotterdam Conventions. At the workshops there have been many useful and concrete discussions. Participants have indicated that these discussions, structured to involve representatives from a number of ministries (such as health, environment, agriculture, and foreign affairs), were useful in terms of the information they received and contacts made.

Chemicals subject to the prior informed consent (PIC) procedure

Chemical	Relevant CAS* number(s)	Category
2,4,5-T	93-76-5	Pesticide
Aldrin	309-00-2	Pesticide
Captafol	2425-06-1	Pesticide
Chlordane	57-74-9	Pesticide
Chlordimeform	6164-98-3	Pesticide
Chlorobenzilate	510-15-6	Pesticide
DDT	50-29-3	Pesticide
Dieldrin	60-57-1	Pesticide
Dinoseb and dinoseb salts	88-85-7	Pesticide
1,2-dibromoethane (EDB)	106-93-4	Pesticide
Fluoroacetamide	640-19-7	Pesticide
HCH (mixed isomers)	608-73-1	Pesticide
Heptachlor	76-44-8	Pesticide
Hexachlorobenzene	118-74-1	Pesticide
Lindane	58-89-9	Pesticide
Mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxyalkyl and aryl mercury compounds		Pesticide
Pentachlorophenol	87-86-5	Pesticide
Monocrotophos (soluble liquid formulations of the substance that exceed 600 g active ingredient/l)	6923-22-4	Severely hazardous pesticide formulation
Methamidophos (soluble liquid formulations of the substance that exceed 600 g active ingredient/l)	10265-92-6	Severely hazardous pesticide formulation
Phosphamidon (soluble liquid formulations of the substance that exceed 1000 g active ingredient/l)	13171-21-6 (mixture, (E)&(Z) isomers) 23783-98-4 ((Z)-isomer) 297-99-4 ((E)-isomer)	Severely hazardous pesticide formulation
Methyl-parathion (emulsifiable concentrate (EC) with 19.5%, 40%, 50%, 60% active ingredient and dusts containing 1.5%, 2% and 3% active ingredient)	298-00-0	Severely hazardous pesticide formulation
Parathion (all formulations – aerosols dustable powder (DP), emulsifiable concentrate (EC), granules (GR) and wettable powders (WP) – of this substance are included, except capsule suspensions (CS))	56-38-2	Severely hazardous pesticide formulation
Crocidolite	12001-28-4	Industrial
Polybrominated biphenyls (PBB)	36355-01-8 (hexa-) 27858-07-7 (octa-) 13654-09-6 (deca-)	Industrial
Polychlorinated biphenyls (PCB)	1336-36-3	Industrial
Polychlorinated terphenyls (PCT)	61788-33-8	Industrial
Tris (2,3-dibromopropyl) phosphate	126-72-7	Industrial

*Chemical Abstract System

Chemicals subject to the interim PIC procedure, but not included in Annex III

Chemical	Relevant CAS number(s)	Category
Binapacryl	485-31-4	Pesticide
DNOC and its salts (such as ammonium salt, potassium salt and sodium salt)	534-52-1; 2980-64-5; 5787-96-2; 2312-76-7	Pesticide
Ethylene dichloride	107-06-2	Pesticide
Ethylene oxide	75-21-8	Pesticide
Monocrotophos (all formulations)	6923-22-4	
Toxaphene	8001-35-2	Pesticide
Dustable powder formulations containing a combination of: benomyl at or above 7%, carbofuran at above 10%, thiram at or above 15%	17804-35-2; 1563-66-2; 137-26-8	Severely hazardous pesticide formulation
Asbestos		Industrial
Actinolite	77536-66-4	
Anthophyllite	77536-67-5	
Amosite	12172-73-5	
Tremolite	77536-68-6	

Chemicals scheduled for consideration at INC 11, 18 September 2004

Chemical	Relevant CAS number(s)	Category
Parathion	56-38-2	Pesticide
Tetraethyl lead	78-00-2	Industrial
Tetramethyl lead	75-74-1	Industrial
Chrysotile asbestos	12001-29-5	Industrial

Where to from here?

The first meeting of the Conference of the Parties, to be held on 20-24 September 2004 in Geneva, Switzerland, will discuss (and potentially take decisions on) a number of very important issues. Among them are the financial rules for the Convention, including the number and type of trust funds to be established. The procedures for arbitrations and conciliations, and for dispute settlement, which were discussed extensively by the Intergovernmental Negotiating Committee, will be decided upon by the CoP. Discussions on the process for dealing with non-compliance have taken place already. A draft text is available for discussion. However, there are a number of unresolved issues.

The first meeting of the CoP will consider the chemicals included in the interim procedure. It will take a decision on adding these chemicals to Annex III of the Convention. The CoP will also need to establish a Chemical Review Committee to scrutinize notifications in order to consider whether these chemicals should be included in Annex III. Finally, the first meeting of the CoP will take a decision on the secretariat's location. The secretariat is currently housed in both Geneva and Rome. There is an offer by the German government to house it in Bonn.

As Parties continue to submit notifications following the CoP, it is anticipated that there will be numerous additional chemicals to consider for addition to Annex III in the future.

Technical assistance is a significant issue for all developing countries. The work of the Intergovernmental Negotiating Committee has provided a good basis for technical assistance, including training workshops. Countries have also been given an opportunity to express their technical assistance needs through a questionnaire circulated to all participating States and observers in 2004. The results of this survey will be presented to the INC at its 11th session for its consideration. The secretariat has also been requested to develop a draft strategy for the regional delivery of technical assistance for consideration by the Conference of the Parties. The strategy for technical assistance developed by the CoP will be the blueprint for work on technical assistance by the secretariat and donor countries over the next year.

The Rotterdam Convention has a number of provisions related to trade. These have been included in the Convention to be consistent with the provisions of the World Trade Organization (WTO). As a trade-related environmental agreement, the CoP may also decide to approach the WTO and request observer status.

Overall, the Convention has made a good start towards meeting its objective to promote shared responsibility and cooperative efforts among Parties with respect to the international trade of certain hazardous chemicals, in order to protect human health and the environment from potential harm and contribute to the environmentally sound use of these chemicals. Active participation of all Parties will be required to keep the work going. It is important that implementation of the Convention by non-Parties be encouraged.

The Rotterdam Convention can be a key element in a coordinated chemicals management strategy. The protection it provides against unwanted imports can help safeguard the health and environment of all countries.

A science-based strategy for chemicals control

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Summary
A number of suggestions are made in this article for amending the data requirements of the proposed European chemicals control system, REACH. These data requirements are shown to be insufficient for applying current criteria to classify substances according to their adverse effects. Use of production volume as a priority-setting criterion for data acquisition is questioned. Three alternative priority-setting mechanisms are proposed: chemical properties of the substance; results from lower tier testing; and incentives for voluntary testing. A new classification category ("insufficiently investigated") is also proposed. Substances in this category would be identified with a warning label.

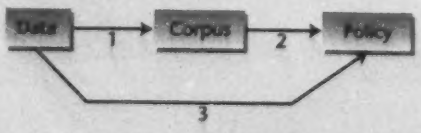
Résumé
L'article avance plusieurs pistes pour modifier les exigences en matière de données du système européen REACH proposé pour réglementer l'usage des produits chimiques. Il montre que ces exigences sont insuffisantes pour appliquer les critères actuels de classification des produits en fonction de leurs effets nocifs. Il s'interroge sur l'emploi du volume de production comme critère de détermination des priorités pour l'acquisition des données. Il propose trois autres mécanismes possibles pour établir les priorités : les propriétés chimiques du produit ; les résultats des essais secondaires ; et des mesures d'incitation en faveur des essais volontaires. Il propose également une nouvelle catégorie de classification (« insuffisamment étudiés ») ; les produits appartenant à cette catégorie seraient signalés par une étiquette de mise en garde.

Resumen
Este artículo presenta una serie de sugerencias para modificar los requisitos de presentación de datos en la propuesta del sistema europeo para el control de sustancias químicas (REACH). Se demuestra la insuficiencia de dichos requisitos en cuanto a la aplicación de los criterios vigentes para clasificar sustancias de acuerdo con sus efectos adversos. Se cuestiona el uso del volumen de la producción como criterio en el establecimiento de prioridades para la obtención de datos. Se proponen tres mecanismos alternos para identificar prioridades: propiedades químicas de la sustancia, resultados obtenidos en pruebas a la capa inferior e incentivos para pruebas voluntarias. Asimismo, se propone una nueva categoría de clasificación ("investigación insuficiente"). Las sustancias incluidas en esa categoría serían identificadas mediante una etiqueta de advertencia.

In practice, the adverse effects that a chemical substance gives rise to depend on two factors: inherent properties and actual exposure. To avoid adverse effects, those responsible for how a substance is used have to adjust the processes (and thereby the exposure) to the substance's inherent properties.

Before a chemical product is used, the risks associated with exposure should be investigated and assessed in accordance with the best available science. Safe handling requirements should also be identified. This information should follow the product, so that it reaches everyone who uses it or is responsible for its use. It is the information on which users of the substance should base decisions concerning avoidance of negative health and environmental effects. This information is also essential for public authorities in their control function in relation to the companies.

Figure 1
Use of scientific data for policy purposes



Source: Hansson 2002

These basic principles seem to be generally accepted. In practice, it is necessary to implement them to satisfy the objectives of major international policies and treaties on management of industrial chemical risks, such as the Strategic Approach to International Chemicals Management (SAICM) (www.chem.unep.ch/saicm/), the Johannesburg Declaration on Sustainable Development (www.johannesburgsummit.org), the Stockholm Convention (www.pops.int), the Rotterdam Convention (www.pic.int), HELCOM (www.helcom.fi) and the Basel Convention (www.basel.int).

Unfortunately, these principles are still far from being realized, largely due to lack of scientific information about chemicals in use. Estimates indicate that between 30,000 and 70,000 chemical substances are on the market in the European Union. The information available on most of them is not sufficient to make even an approximate estimate of adverse effects. An important attempt to remedy this situation has been made by the European Commission in its proposed new system for chemicals control, the REACH system (European Commission 2003).

In this article we analyze the data requirements in the REACH system, and how it can be amended to improve the scientific basis of industry's risk assessments. The article is based on results obtained in the research programme NewS ("A new strategy for risk assessment and management of chemicals"), funded by MISTRA, the Swedish Foundation for Strategic Environmental Research (www.infra.kth.se/phil/NewS).

Using science for policy purposes

Health risk assessments of chemicals have to be based on scientific data that is as relevant as possible for the risk assessment. But due to ethical and economical restraints, for example, highly relevant testing (such as experiments on humans or full-scale environmental experiments) is impossible.

Extrapolation of data is common practice, e.g. from animal experiments to human risk or from single species to a complex multi-species ecosystem. Obviously, both under- and overestimation of risk can result from such extrapolations.

Figure 1 illustrates the use of scientific data for policy purposes (Hansson 2002). Through a process of critical assessment, data originating in experiments and other observations give rise to the scientific corpus (arrow 1). Roughly speaking, the corpus consists of those statements that could, at the time, legitimately be made without reservation in a (sufficiently detailed) textbook.

The obvious way to use scientific information for policy purposes is to use information from the corpus (arrow 2). For many purposes this is the only sensible thing to do. In the context of protecting health and the environment, however, exclusive reliance on the corpus may have unwanted consequences. Suppose there are suspicions,

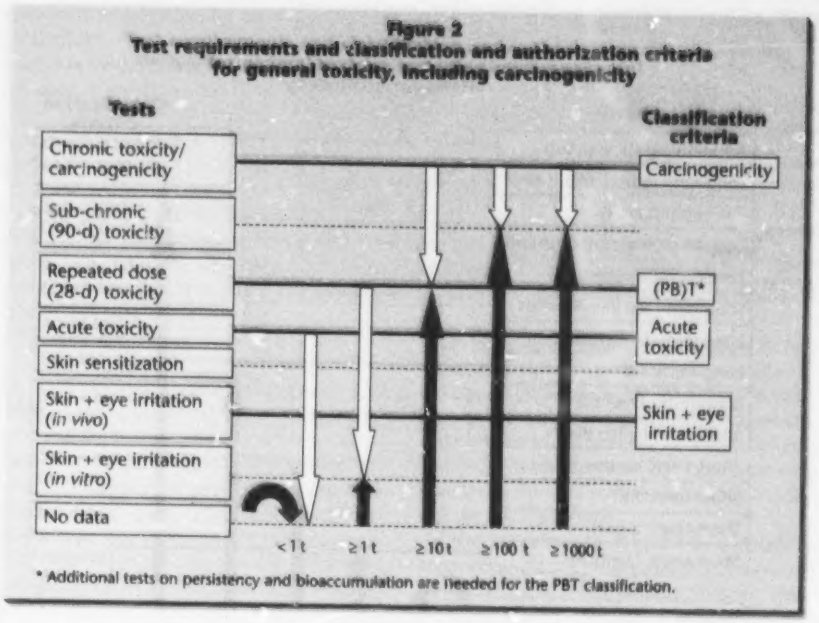


Figure 2
Test requirements and classification and authorization criteria for general toxicity, including carcinogenicity

based on relevant but insufficient scientific evidence, that a certain chemical substance is dangerous to human health. Since the evidence is not sufficient to warrant an addition to the scientific corpus, this information cannot influence policies in the "standard" way (arrows 1 and 2). The evidence may nevertheless be sufficient to warrant changes in the handling and use of that chemical. In cases like this, we want to have a direct road from data to policies (arrow 3). As one example, consider a case in which there are strong indications that a certain substance is carcinogenic, but the evidence does not amount to full scientific proof. It is reasonable for an industrial decision-maker or a regulator to take precautionary action in such a case.

The process represented by arrow 3 differs from that of arrow 1 in being a decision with direct practical consequences. Therefore, it is rational to take the practical effects of the decision into account and adjust the burden of proof accordingly. It is important, when this is done, to continue to be guided by science and not to replace it by arbitrary decisions or the whims of uninformed opinion. As we see it, a rational decision-maker who takes a precautionary approach should use the same type of scientific evidence (and assign the same relative weights to different kinds of evidence) as a decision-maker who requires more complete scientific evidence before action is taken. We call this approach *science-based precaution*. Due to the uncertainty inherent in toxicology, science-based precaution is in our view an indispensable element of a chemicals strategy that strives to avoid the serious mistakes of the past.

The REACH proposal

In the current EU chemicals regulations, different rules apply to "new" and "existing" substances. (This distinction is based on whether a chemical was put on the market in the EU before or after the 18th of September 1981). New substances must be tested and notified before they are put on the market. No testing is mandatory for existing chemicals; these substances are to be risk assessed one by one on the basis of available data. Major shortcomings of current regulations are the general lack of data requirements for existing substances, and the slow and resource-intensive risk assessment process.

A review of the regulations was initiated at the informal Council of Environment Ministers in April 1998. Three years later, in February 2001, the European Commission presented a White Paper drawing up a strategy for a future chemicals policy. On 7 May 2003 the first public version of a new framework for the Registration, Evaluation and Authorization of CHemicals was published. Based on an eight-week internet consultation and further discussions with all interested parties, a revised REACH proposal was published in October 2003 (European Commission 2003).

The objectives of REACH with respect to risk assessment can be summarized in the form of two overarching goals. First, REACH aims at improved knowledge about the risks associated with the use of individual chemical substances. Secondly, REACH is intended to increase the speed and efficiency of the risk assessment process, and to make producers and importers of chemicals responsible for this process. In this article we focus on the first of these goals.

In REACH all general industrial chemicals are regulated under a single system. The previous lack of correspondence in test requirements for new and existing substances will be eliminated. According to REACH, all chemicals with production volumes of 1 tonne or more per year (and per manufacturer) must be registered in a central database. The registration will be evaluated by the authorities. The result of the evaluation may be that the substance is subjected to authorization requirements or to use restrictions.

As previously mentioned, one major aim of REACH is to improve the efficiency of the risk assessment process. This is done by requiring industry to make a preliminary risk assessment (*chemical safety assessment*) of chemicals. In this assessment manufacturers or importers must show that the risks of all identified uses are adequately controlled. This requirement is limited to substances with production volumes of 10 tonnes or more per year and per manufacturer. For substances produced in lower volumes (1-10 tonnes) a safety data sheet is required for substances classified according to the EU criteria for classification and labelling of dangerous substances.

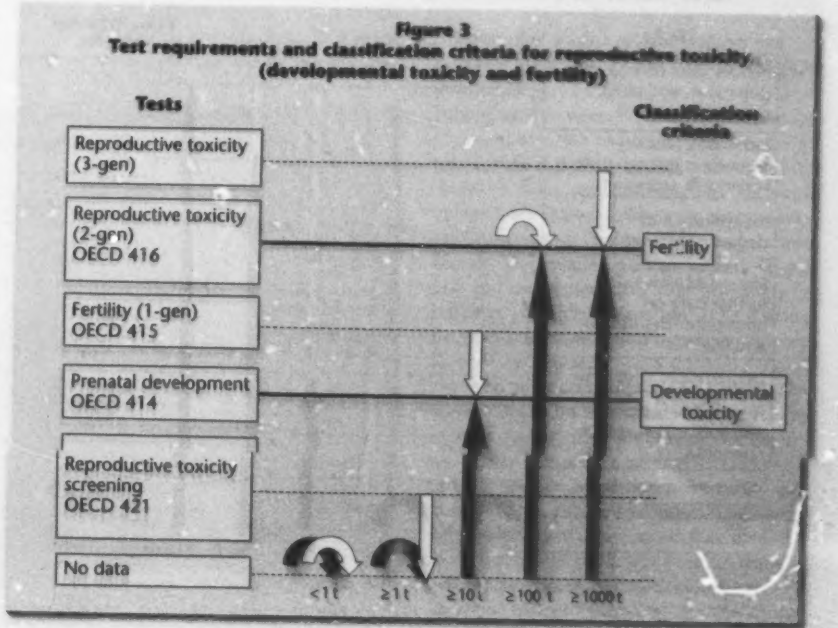


Figure 3
Test requirements and classification criteria for reproductive toxicity (developmental toxicity and fertility)

The authorization procedure will be applicable to substances of "high concern", such as substances that are carcinogenic, mutagenic or toxic to reproduction, substances that are persistent, bioaccumulating and toxic (PBT), substances that are very persistent and very bioaccumulating (vPvB), and endocrine disrupting chemicals (ED). Use of such substances is authorized only if the manufacturer can show that risks to human health are adequately controlled.

With REACH, a central European Chemicals Agency will be established.

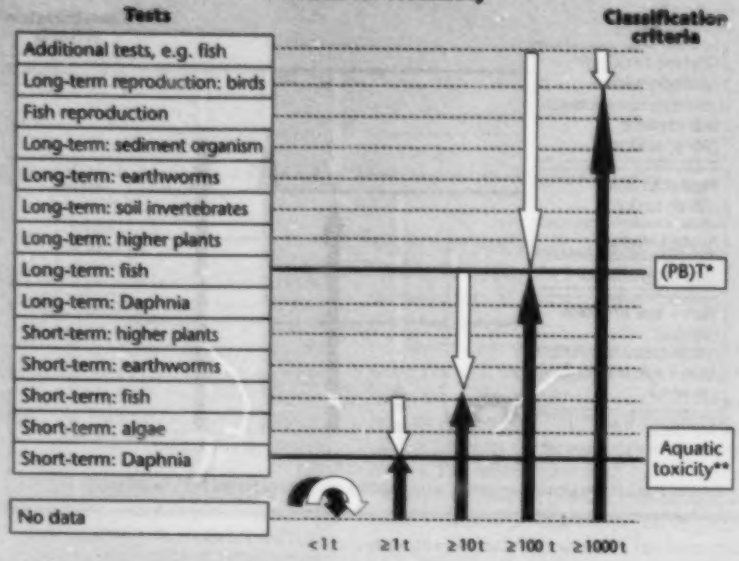
An appraisal of the REACH data requirements

How well-informed are we about the possible adverse effects of a substance when we have the data required in REACH? This can be evaluated by comparing the required data sets to the data needed to classify a substance according to the EU Classification and Labelling Directive (67/548). It is also useful to compare the data requirements with the REACH criteria for authorization.

The test requirements of REACH are summarized in Figures 2-5. The required data are listed at the left. Black and white arrows indicate how test requirements will change for "existing" and "new" substances, i.e. substances notified to the Commission before and after the 18th of September 1981, respectively. Test requirements also depend on annual production volume, which is classified in one of five ranges (<1 tonne, ≥1 tonne, ≥10 tonnes, ≥100 tonnes, and ≥1000 tonnes).

In REACH the previous distinction between test requirements for "existing" and "new" substances is abolished. Test requirements according to REACH are therefore where the black and the white arrows meet. All tests up to and including the point where the arrows meet are required for the respective production volume category. Data requirements for the classification and authorization criteria are indicated to the right.

Figure 4
Test requirements and classification and authorization criteria for ecotoxicity

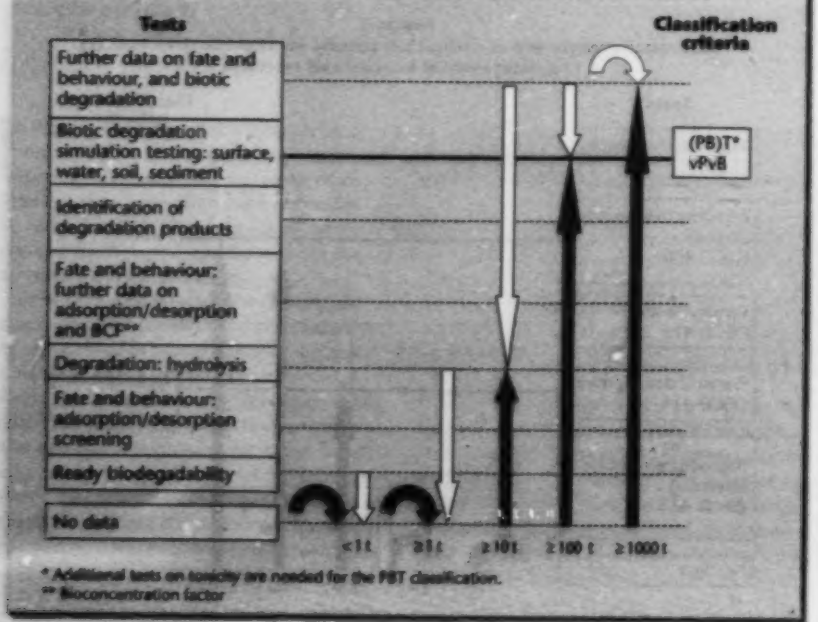


* Additional tests on persistency and bioaccumulation are needed for the PBT classification.
** Additional tests on biotic degradation and lipophilicity or bioaccumulation are needed for classification of acute aquatic toxicity.

Acute toxicity (Figure 2)

For substances with production volumes of 10 tonnes or more, the data required in REACH will be sufficient to apply the classification criteria for skin and eye irritation and for acute (mammalian) toxicity. For substances with production volumes of less than 10 tonnes, none of the criteria for acute effects on mammals is applicable. In other words, the data required in REACH are not sufficient to determine whether these substances should be labelled for acute toxicity.

Figure 5
Test requirements and authorization criteria for fate and behaviour in the environment (persistency and bioaccumulation)



* Additional tests on toxicity are needed for the PBT classification.
** Bioconcentration factor

Carcinogenicity (Figure 2)

Long-term carcinogenicity testing is not required in any of the standard test batteries in REACH (regardless of production volume). Hence, the criteria for carcinogenicity classification will not be applicable to the test data generally required in any production volume.

Reproductive toxicity (Figure 3)

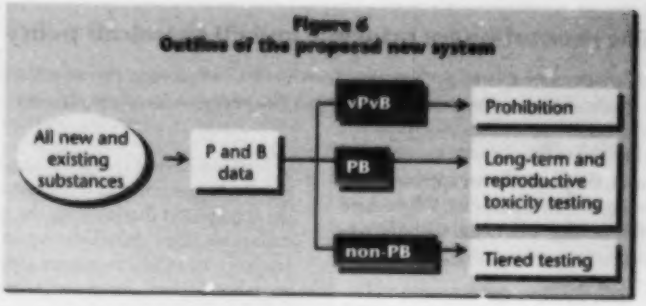
Data required in REACH are sufficient for classification of developmental toxicity for substances with production volumes of 10 tonnes or more. Classification for adverse effects on fertility is based on data that are only required for substances with production volumes of 100 tonnes or more. For substances with production volumes of less than 10 tonnes, no classification for reproductive toxicity is possible on the basis of the required data only.

Ecotoxicity (Figures 4 and 5)

The data required in REACH will be sufficient to apply the classification criteria for aquatic toxicity for substances with production volumes of 10 tonnes or more. For substances with production volumes of 100 tonnes, data on acute toxicity in *Daphnia* are required. However, data on biotic degradability ("ready test") are only required for

substances with production volumes of 10 tonnes or more, and these data are also needed for classification of aquatic toxicity. The REACH system specifies criteria for classifying substances as PBT (persistent, bioaccumulating and toxic) and as vPvB (very persistent and very bioaccumulating). However, it is only for substances with production volumes of 100 tonnes or more that the required data are sufficient for applying the PBT and vPvB criteria.

Figure 6
Outline of the proposed new system



In summary, with the implementation of REACH, data requirements for "existing" chemicals will increase while the requirements for "new" chemicals are reduced. Existing substances represent about 99% of production volume, which means the total effect is in the direction of an improved knowledge base for risk assessment. However, that improvement is not sufficient to provide the information required for classification and authorization decisions.

For substances with production volumes of 10 tonnes or more, the required information is not enough to apply any of the classification or authorization criteria under consideration here (i.e. acute mammalian toxicity, acute aquatic toxicity, skin irritation, eye irritation, skin sensitization, carcinogenicity, reproductive toxicity, PBT or vPvB). Only for substances with production volumes of 100 tonnes or more is the required information sufficient to potentially trigger the REACH authorization process. For none of the substances regulated by REACH will the required information be sufficient to classify for carcinogenicity.

Improved priority-setting

As we have already seen, in REACH (as well as in current regulations) production volume determines test requirements. The higher a particular substance's production volume, the more extensive is the required test battery. The rationale for using production volume as a priority-setting tool is the assumption that higher production volume is associated with higher potential for exposure, and therefore with higher risk of adverse effects. This is a sensible argument, but the connection between total production volume and risk is indirect and not at all certain.

There are at least three problems with using production volume to determine test requirements. First, due to lack of research in this area, the extent to which production volume predicts exposure is essentially unknown. Secondly, a positive correlation between production volume and exposure does not necessarily lead to an equally strong positive correlation between production volume and risk. Risk depends on a combination of exposure and toxicity. Substances with low toxicity may be over-represented among high-volume substances (Cunningham and Rosenkranz 2001). Thirdly, even if total exposure to a low-volume substance is low, individual exposures may be high, e.g. in the workplace.

In our view, the role of production volume as a priority-setting criterion for data acquisition should be gradually reduced. Instead, we propose three other mechanisms for priority-setting:

1. Chemical properties of the substance

Substances with different chemical characteristics will have a different fate and behaviour in the environment (e.g. partitioning, persistency, ability to bioaccumulate). They will also require different approaches to testing (e.g. due to their lipophilicity) and will differ in their propensity to potentially adverse reactions with biological material (reactivity). Chemical characterization with regard to reactivities, persistency and bioaccumulative potential can thus be used both for priority-setting and to improve testing strategies.

2. Results from lower tier testing

Use of tiered testing should be strengthened, so that certain results in a lower tier test automatically lead to requirements for further testing. For example, substances that are acutely toxic to *Daphnia* should be tested for short-term effects in fish and algae; in case of positive findings in these tests, long-term testing in aquatic species should also be performed.

3. Incentives for voluntary testing

Mechanisms should be created to give producers incentives to test particular low-volume substances more extensively than the minimum requirements.

An amended system of testing requirements

In the amended system that we propose, all substances are subjected to an initial chemical characterization with regard to their reactivities and their persistency and bioaccumulative properties. Based on these data, substances should be classified as either:

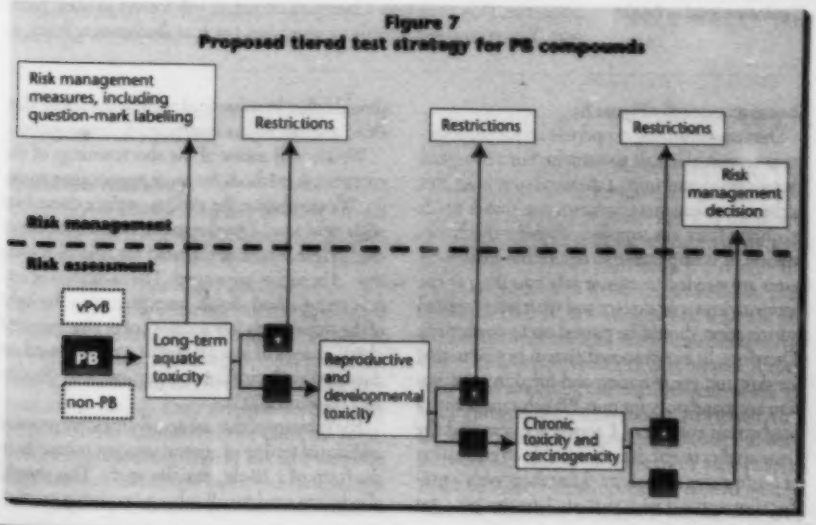
1. very persistent and very bioaccumulating (vPvB);
2. persistent and bioaccumulating (PB); or
3. having low persistence and potential for bioaccumulation (non-PB).

Criteria for such a classification are already available in the current REACH proposal.

Substances that are both persistent and bioaccumulating can give rise to toxic effects after a greater time and at a greater distance than other chemicals. Long-term exposures and exposure of unborn and newborn children to these substances can be anticipated. Previous experience has shown that vPvB substances should not be used. We propose that use of substances with these properties should in principle be prohibited. This is stricter than the authorization process currently proposed in REACH (**Figure 6**).

For PB substances, we propose a tiered test system starting with a long-term test for aquatic toxicity. If this is negative, a reproductive and developmental study in mammals is required; if it turns out negative, a chronic toxicity and carcinogenicity study is mandatory. Use of PB substances classified for any of these toxicological effects (i.e. toxic PB substances) should be restricted and, if at all allowed, accompanied by appropriate precautionary measures including emission control

Figure 7
Proposed tiered test strategy for PB compounds



The precautionary principle and EU chemicals policy

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> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.
>
> **Principle 15 of The Rio Declaration on Environment and Development (1992)**

The EC Treaty has incorporated the precautionary principle since 1992 (Treaty of Maastricht), although without defining it in any detail. Its incorporation into the Treaty is highly significant and should set the stage for environmental protection measures to be undertaken quickly, before "absolute proof" of harm is evident.

In 1999 the Council of Ministers adopted a Resolution urging even more determination to be guided by the principle, further emphasizing acceptance of its place in EU policy and law. As noted by the European Commission, *"applying the precautionary principle is a key tenet of [Community] policy"*.[1] It is recognized that the precautionary principle applies in both environmental and health spheres.[2]

> **The precautionary principle in the Treaty**
>
> Community policy on the environment shall aim at a high level of protection taking into account the diversity of the situations in the various regions of the Community. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.
>
> **Maastricht Treaty (now the Amsterdam Treaty, Art 174(2)), 1992**

However, putting the precautionary principle into practice is conceptually and politically challenging. In 2000 a Communication from the European Commission attempted to set out an approach and guidelines for using and applying the principle.[3] This was partly in response to accusations of "arbitrary" decision-making, since use of the precautionary principle is regarded by some non-EU countries – the US in particular – as restricting trade. There is also potential for conflict even between EU countries if there is no common acceptance of how to interpret the principle.

A key argument for the Commission was that World Trade Organisation rules incorporate the precautionary principle,[4] recognizing the *"independent right"* of countries *"to determine the level of environmental or health protection they consider appropriate."*

The Commission's paper has turned out to be controversial. The Commission has proposed that risk assessment and management is central to the concept and that invoking the principle has to start with a scientific evaluation, albeit one which should be explicit about any uncertainties. Intrinsic hazardous properties alone should not trigger the principle according to the Commission. Given the problems with risk assessment (which needs both hazard and exposure information) in chemicals regulation, environmentalists viewed this as a weak start.

The Commission also noted that precautionary action should be based on cost-benefit analysis, with the proviso that non-economic factors could be taken into account. But it is feared that this may turn to the advantage of economic short-term interests that can quantify their costs more easily. Sweden has argued that it should be about cost-effectiveness and not cost-benefit analysis,[5] which accords more with environmentalists' views. Principle 15, in our view, should be interpreted as finding the cost-effective way to take action once the decision to act has been taken, and not about using cost-benefit analysis to decide whether to act or not.

Precaution and the chemicals policy debate

Debate about the precautionary principle is very pertinent to current discussions on the regulation of chemicals. In many ways, much current chemicals policy in the EU is the antithesis of the precautionary principle and concerns about the current lack of regulation. Our ignorance about most chemicals in use, and worries about a number of synthetic chemicals being found in human tissue, have led the European Commission to produce legislative proposals.

The historic and unregulated production of chemicals means that we have all grown up in a society that produces and uses thousands of chemicals in an almost infinite variety of ways. Our world is made up of chemicals – so much so that the European chemical industry employs 1.7 million people and produced over EUR 500 billion worth of chemicals in 2002. The industry is making much use of impact assessments to try to show the harm to industry that new regulations will bring. Yet the vast majority of chemicals (aside from certain groups such as medicinal products, pesticides and newly registered chemicals) have never had basic safety assessments undertaken. Their use has been taken for granted and, in general, manufacturers have not been required to provide safety data for the 100,000 chemicals that were known to exist and catalogued back in 1981.

We are exposed to probably hundreds of synthetic chemicals every day. Hazardous chemicals can be found in all sorts of household goods – clothes, cosmetics, PCs, even toys. Chemicals do not sit still forever in these products. We are exposed directly in some uses (such as shampooing hair), or

and environmental monitoring. If all toxicity studies are negative, use of the substance may be considered (**Figure 7**).

For substances with low persistence and potential for bioaccumulation (non-PB) we propose a tiered testing system in which production volume and results from previous tests determine further test requirements and risk management decisions. This system includes five parallel pathways for tiered testing (Hansson and Rudén 2004):

1. general acute toxicity;
2. general sub-acute to chronic toxicity;
3. reproductive toxicity;
4. mutagenicity;
5. ecotoxicity.

Here we will briefly outline the principles of this system, using the tests for general (acute) toxicity as an example (**Figure 8**).

Data on sensitizing properties and acute toxicity are essential in risk assessment. For a company that is considering using a chemical substance, this is the most elementary information that it needs to obtain from the supplier. Without this information, it is impossible to determine what measures are needed to ensure safe handling at the company's own workplace and what safety-related information should be passed on to customers. Therefore, in our proposed system *in vivo* testing for skin and eye irritation and for skin sensitization are mandatory for non-PB substances with a production volume of 1 tonne per year, and the same applies to test data that enable an estimation of acute systemic toxicity. Substances with a production volume of less than 1 tonne per year should either be submitted to these tests or be classified and labelled as insufficiently investigated.

We are well-aware of the shortcomings of the current test methods for acute mammalian toxicity. We emphasize the need to replace these tests with new ones. Development and validation of methods that reduce the need for animal testing should be highly prioritized. The usefulness of any new test method should be evaluated in the light of the surprisingly low accuracy of the harmonized classifications of acute systemic toxicity based on data obtained with current test methods (Rudén and Hansson 2003).

For substances that are acutely toxic we propose additional testing of general toxicity, primarily in the form of a 28-day toxicity study. This should also be required for all substances with a produc-

they may migrate out of articles during use, accidental damage and disposal. We can be exposed to persistent chemicals not just during their initial use, but through the food chain, through dust, and even in the womb. Many long-lived synthetic chemicals are now found in our bodies and the environment. They contaminate the oceans and polar regions and their wildlife.

Environmentalists are particularly concerned about persistent and bioaccumulative chemicals. A number have hormone-like properties and may interfere with the endocrine system in subtle ways, possibly causing birth defects, decreases in sperm count and increases in certain types of cancer, for example. Yet when concerns are raised about specific chemicals, the battle for regulation is often long and fierce, with manufacturers forcing a very high burden of proof before decisive action to restrict or ban the chemical can be taken. In the meantime, production may continue for many years. Even when proof of harm is accepted, the chemicals are still circulating the world and much harm will continue. Environmentalists think such chemicals should be banned because of their intrinsic properties, without having to wait years for evidence to accumulate.

The current problem can be illustrated by the prolonged struggle over a group of possible endocrine-disrupters called phthalates, which are added to some plastics and which have been used in some toys. The European Commission has managed to instate a number of temporary bans on their use in toys that are intended to be put into the mouths of children under three. But in the view of environmentalists this is a rather weak measure and still leaves the possibility of widespread exposure through other routes. Phthalates have been found in human tissue and may be present in glues and many PVC products.

It is hoped that the new legislation, once finally agreed, will really push manufacturers to substitute persistent and bioaccumulative chemicals with safer chemicals if at all possible – unless there is an essential societal use of the chemical that outweighs the concerns. By definition in the new legislation, chemicals that are carcinogenic, mutagenic, reproductive toxins, very persistent and very bioaccumulative, or that have endocrine-disrupting properties, are regarded as of "very high concern". In general, such chemicals will be candidates for the authorization process of REACH, a system that would ban all uses unless specifically authorized.[6]

However – and here we get to the flaw – the current draft introduces a concept of "adequate control". This would authorize continued use of substances of very high concern in certain circumstances even if a safer substitute were available. To our mind, it is impossible to truly control very persistent, very bioaccumulative chemicals. And since they may have subtle effects at very, very low concentrations which current toxicity testing regimes are finding difficult to assess, we should really be very uncomfortable at their continued use. These intrinsic properties should make them unacceptable for use except in extreme circumstances. So the draft legislation falls far short of implementing a precautionary principle at the moment. It also introduces the notion that many endocrine-disrupting substances have to be shown to have "serious and irreversible effects to humans or the environment", surely another contradiction to the precautionary principle.

While the legislation is still under discussion, the question of whether the precautionary principle will be fully reflected in the final legislation remains open. We hope our EU politicians will be brave enough to take action that will declare some chemicals guilty without years of experiments and observation of harm, and that will have impacts for generations to come.

The precautionary principle should embrace a number of components:

- transparency and public participation;
- respect of societal (non-scientific) values;
- reversal of the burden of proof;
- consideration of a wide range of alternatives (including the possibility of not undertaking a proposed development);
- early preventive action in response to reasonable suspicion of harm;
- recognition that lack of evidence is not the same as evidence of no harm;
- recognition of the limits of scientific knowledge and understanding;
- research to address the gaps in knowledge, but without delaying other possible actions.[7]

Notes

1. Communication from the Commission on the Precautionary Principle. COM (2000) 1 final. Brussels, 2.2.2000.
2. For example, the Declaration of the Third Ministerial Conference on Environment and Health (London, 1999) re-affirmed commitment to the principle, noting the need *"to rigorously apply the precautionary principle in assessing risks and to adopt a more preventive, pro-active approach to hazards."* The principle is also explicit in the Stockholm Convention on Persistent Organic Pollutants.
3. Communication from the Commission on the Precautionary Principle, *op. cit.*
4. The Communication specifically referred to the Agreement on Sanitary and Phytosanitary Measures and the Agreement on Technical Barriers to Trade.
5. Swedish Committee on New Guidelines on Chemicals Policy, Non-hazardous products? Proposals for implementation of new guidelines on chemicals policy. *SOU* 2000:53, June 2000.
6. See the accompanying article, "A science-based strategy for chemicals control" by Sven Ove Hansson and Christina Rudén.
7. For example, Kriebel, et al., *Environmental Health Perspectives* 109:871-75, 2001; European Environmental Bureau, *Position Paper on the Precautionary Principle*, "The precautionary principle in environmental science," 1999.

tion volume of more than 10 tonnes per year (in accordance with REACH).

Question-marking

In the current classification and labelling system, additional data about the properties of a substance can lead to a stricter classification – but almost never to a less strict one (Hansson and Rudén 2003). A strict classification tends to diminish a substance's marketability. Companies responsible for producing and marketing chemical substances often have something to lose from subjecting their products to testing. They almost never have anything to gain in economic terms. Thus, the classification and labelling system has an incentives structure that discourages rather than encourages toxicity testing. This counterproductive incentives structure will remain in the proposed REACH system.

Let us consider a hypothetical example. One company produces and markets dye-stuff A, whereas another company produces and sells the closely related dye-stuff B. Both are produced in volumes below 10 tonnes per year; in each case only the required data for such substances are available. Each substance is in fact a developmental toxicant, but the initially available data sets give no indication of this. The company producing substance A then voluntarily undertakes an extensive state-of-the-art testing programme for its product. As a result, it has to classify and label the substance as toxic and warn its customers against the substance's toxic properties. The other company performs no tests on substance B. Therefore, substance B will not have to be classified or labelled as toxic. A will be more difficult to sell than B.

This outcome is, of course, in sharp contrast to the stated aims of national and international chemicals policies. We have good reasons to prefer a toxic product that is classified and labelled as toxic to an equally toxic product that is neither classified nor labelled.

One way to improve the regulatory system in this respect is to introduce an additional dimension into the classification and labelling system, namely the dimension of toxicological ignorance, coupled to a new classification category, *insufficiently investigated* (Hansson and Rudén 2003). Substances classified in this category should be assigned a warning label, including a symbol such as a question mark that enables users to exercise

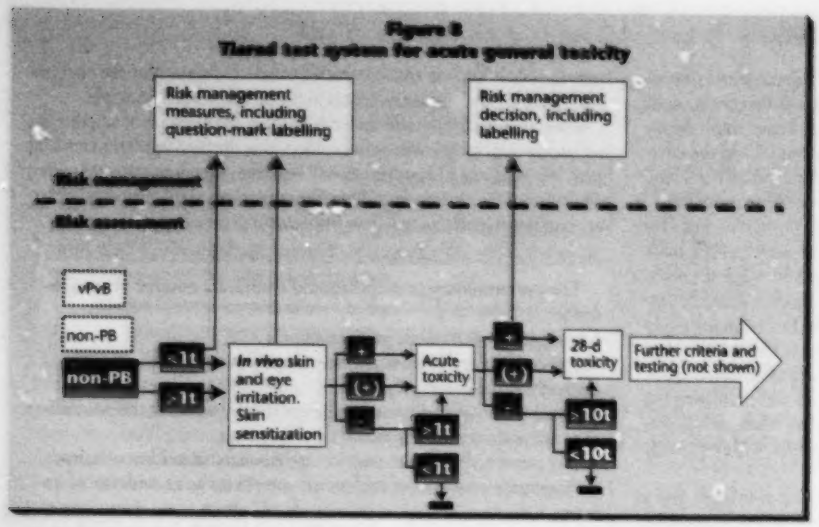

Figure 8
Tiered test system for acute general toxicity

the caution they consider to be motivated by the lack of scientific information about the substance (**Figure 9**).

The question mark label would inform potential users that a substance could have unknown hazardous properties. Classification as "insufficiently investigated" could be expected to have a similar effect to classification as toxic or dangerous to the environment. By submitting low-volume chemicals to a certain level of testing above the minimal requirements, on the other hand, the companies that produce these chemicals could achieve the competitive advantage of not having to "question mark" them.

The minimum data set that we propose for avoiding question-mark labelling includes data from skin and eye irritation testing (*in vivo*), skin sensitization, mutagenicity testing of mammalian cells (*in vitro*), acute systemic toxicity, developmental toxicity and short-term aquatic toxicity (crustacean species, algae and fish).

Figure 9
Proposed new label for insufficiently investigated substances

Chemical safety consists not only in avoiding known problems, but also in avoiding (as far as possible) exposures with unknown or uncertain effects on health and the environment. Therefore, a rational chemicals policy needs to make full use of science. This means that all types of scientific information should be used, including information about what is not yet investigated or is (for other reasons) uncertain.

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Integrated chemical management: dream or reality in the developing world?

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Summary

South Africa's chemical industry has changed significantly in the last ten years. Representatives of government, industry and labour are currently developing a national strategy to improve the industry's global competitiveness. Chemical management is one of the areas addressed. Ways to develop more integrated approaches to implementation of international chemicals control initiatives are described in this article. Implementing the Globally Harmonized System of Classification (GHS) will be a challenge for both developing and developed countries. However, the GHS is a sound starting point for an integrated approach to chemical management.

Résumé

L'industrie chimique d'Afrique du Sud a considérablement évolué depuis dix ans. Des représentants du gouvernement, de l'industrie et des travailleurs ont entrepris d'élaborer une stratégie nationale pour améliorer la compétitivité globale du secteur. Parmi les aspects abordés figure la gestion des produits chimiques. L'article décrit les pistes possibles pour élaborer des approches plus intégrées de la mise en œuvre des initiatives internationales de réglementation des produits chimiques. Mettre en pratique le Système général harmonisé (SGH) pour la classification des produits chimiques est une gageure pour les pays en développement comme pour les pays développés. Mais c'est un bon point de départ pour une approche intégrée de la gestion des produits chimiques.

Resumen

La industria química de Sudáfrica ha cambiado considerablemente en los últimos diez años. Diversos miembros del gobierno, la industria y el sector laboral se encuentran formulando una estrategia nacional para mejorar la competitividad mundial de la industria; la gestión de sustancias químicas es uno de los temas incluidos en dicha estrategia. Este artículo describe diversas vertientes para el desarrollo de enfoques más integrales orientados a la ejecución de iniciativas para el control internacional de las sustancias químicas. La aplicación del Sistema Mundial Armonizado de Clasificación (GHS) representa un desafío tanto para los países en desarrollo como para los países desarrollados. Sin embargo, el GHS es un punto de partida firme hacia la gestión integral de sustancias químicas.

The South African chemical industry is dominated by local companies. They developed from the industry's historical base in the provision of explosives for the mining industry, followed by the production of nitrogen-based fertilizers and sulphuric acid. The strategic decision in the 1950s to adopt the Fischer-Tropsch process to derive oil from coal on a large scale led to the foundation of a significant polymer industry.

Although it is relatively small by international standards, South Africa's chemical industry contributes around 5% national gross domestic product and employs approximately 150,000 people. Annual production of primary and secondary process chemicals is in the order of 13 million tonnes, with a value of around 18 billion rand. The industry is the largest of its kind in Africa.

Since 1994 the chemical industry has undergone a significant transformation to meet the challenges posed by the opening up of the economy. Re-entry into the international community has entailed a number of challenges in all areas of environmental management, including the sound management of chemicals.

The government has identified the chemical industry as having potential for growth in a range of subsectors (e.g. downstream beneficiation of domestic raw materials). Representatives of government, the chemical industry and organized labour are engaged in developing a national strategy to improve the industry's global competitiveness. Such a strategy would not be complete if it did not include the issue of chemical management.

In view of the competitive imperative to manage chemicals safely, stakeholders have agreed that some key elements with respect to this topic should be included in the agreement on a national strategy for the country's chemical industry.

International initiatives

At the international level, the chemical industry is one of the world's most highly regulated industries. Among other factors, the global industry's competitiveness depends on demonstrating the ability to implement international initiatives at the national level.

Recent global developments indicate that there is increasing demand in multilateral fora for more integrated approaches to chemicals management. Delegates to the first Preparatory Meeting for the Development of a Strategic Approach to International Chemicals Management (SAICM) in Bangkok in November 2003 emphasized the need for more harmonized approaches to chemical management.[1]

International commitments can be broadly divided into two categories: legally binding obligations and other international initiatives.

Legally binding obligations include:

- the Chemical Weapons Convention;[2]
- the Convention against the Illicit Traffic in Narcotic Drugs and Psychotropic Substances.[3]
- the Montreal Protocol;[4]
- the Stockholm Convention on POPs;[5]
- the Rotterdam Convention on prior informed consent.[6]

Other international initiatives include:

- the Bahia Plan of action endorsed at the World Summit on Sustainable Development (WSSD) in Johannesburg;[7]
- ILO Conventions on safe use of chemicals;[8]
- the Globally Harmonised System of Classification and Labelling of Chemicals (GHS);[9]
- various capacity building initiatives.

It is clear that a number of potential synergies exist among these initiatives. For example, classification and labelling is required in order to implement mechanisms for regulating chemicals. Thus, the GHS can be seen as an initiative underpinning many others.

All international initiatives require countries to prepare and present national positions at international meetings, and to submit implementation reports to the appropriate secretariats. Many initiatives require control of transboundary movements of chemicals.

All these initiatives can be contextualized in some way within national strategies. For example, phasing out specific pesticides should be seen as an integral part of good agricultural practice (which, in turn, is becoming increasingly important to promote market access).

Responsibility for implementing international initiatives often rests with national entities, which have a narrow mandate and do not necessarily perceive international obligations related to chemicals in the context of the national imperative – for

example, in most developing countries – to alleviate poverty and improve the quality of life.

Some possible ways to develop more integrated approaches to the implementation of international initiatives are set out below. Development of coherent approaches at the national, regional and international levels depends on adopting mutually reinforcing approaches at all levels. How this could be achieved is also discussed.

Sound management of chemicals as a competitiveness factor

Sound management of chemicals involves ensuring that they are managed throughout their life cycle in ways that result in minimum adverse effects. Increasingly, chemical suppliers' customers are demanding, *inter alia*, sound information about chemicals' hazards to ensure that production processes do not have significant adverse effects on human health or the environment and that the chemicals are transported safely.

These demands by customers along the chemical value chain can have a significant impact on suppliers' competitiveness. They are increasingly being recognized by the chemical industry as important to the industry's continued competitiveness. This is particularly relevant in emerging markets, where legislative controls traditionally may not meet international norms.

Mainstreaming sound chemicals management into the industry's economic and investment strategies is a powerful instrument for promoting improved performance at the national level. Moreover, industry automatically seeks to streamline compliance with requirements and so makes a useful partner for governments in this regard.

The impact of national activities on regional and international coherence

Fragmentation of national approaches to regional and international instruments results in ministries engaging in activities at the regional and international levels without necessarily consulting with other relevant ministries. An example has been the almost complete absence of participation by economic ministries in the development of multilateral instruments like the Montreal Protocol and the Rotterdam Convention, both of which contain significant import/export control provisions.

As import and export control is generally the responsibility of economic ministries, these ministries are best able to develop national systems that could accommodate the import/export control requirements of all international chemical instruments.

Lack of national coherence is then reflected in international instruments. Likewise, in their inputs to institutions like the World Customs Organization (WCO)[10] economic ministries do not necessarily address the difficulties that could be experienced in implementing the import/export control provisions of multilateral environmental agreements.

Conversely, the international secretariats responsible for multilateral environmental instruments should seek greater coherence between themselves and their more economically and socially focused international counterparts (e.g. the WCO and the World Bank).

Taking advantage of synergies

It is clear that there are potential synergies among multilateral agreements regarding import/export control. In addition, more streamlined reporting mechanisms are possible. A more coherent approach to reporting would not only allow better informed identification of capacity building needs at the international level, but would also promote national coherence and coordination.

The existence of potential synergies among various elements of the Bahia Declaration and GHS implementation is also clear. National implementation strategies should take this into account, and international capacity building initiatives should support national efforts to exploit such synergies.

The role of international support for capacity building

Support for international capacity building can play a major role in improving national coherence – if this support is provided in a coordinated and holistic way. The mandates of international agencies are generally quite specific, and often they do not take national institutional arrangements into account.

Cleaner production centres promote the development of a coherent approach to sound chemical management, which is an integral part of cleaner production in any industry where chemicals are produced or used. UNIDO and UNEP support for National Cleaner Production Centres provides an opportunity to integrate sound management of chemicals and more competitive industrial development.[11]

The Globally Harmonized System of Classification and Labelling of Chemicals

Implementing the Globally Harmonized System of Classification will be a challenge to developing and developed countries alike.[12] The GHS is a sound starting point for an integrated approach to chemical management. It addresses two key elements of an integrated approach:

- classification of a hazard;
- communication of the hazard.

Implementing this initiative provides an opportunity to develop a platform for sound management of chemicals along the value chain. A strategy for implementing the GHS in South Africa has been developed using a multi-stakeholder process, with funding from the South African government and the UN Institute for Training and Research (UNITAR).[13]

Agreement on an implementation strategy has been reached among industry, labour and the responsible regulators under the auspices of South Africa's National Economic Development and Labour Council. The agreement is now being incorporated in the sectoral agreement among the chemical industry, government and labour on a sectoral strategy to promote the industry's global competitiveness.

Capacity building

In preparation for the 2002 World Summit on Sustainable Development, the International Council of Chemical Associations (ICCA)[14] commissioned case studies on capacity building. One of these was undertaken in South Africa.

Key stakeholders (government, industry and civil society organizations) with an interest in capacity building and awareness raising in the chemical industry were consulted. The specific capacity building needs and obligations identified by stakeholders in each sector are summarized below.

Government

- Chemicals management capacity within government needs to be integrated and coordinated. Relevant policies and legislation (e.g. labelling requirements and implementation of UNEP's APELL[15] Programme) need to be coordinated.
- Appropriate mechanisms should be established to raise public awareness of chemical safety through disseminating information that includes industrial emissions, safer alternatives, and the diagnosis and treatment of chemical poisoning.
- Customs and excise capacity needs to be enhanced to control transboundary movements of chemicals.
- Capacity within government departments needs to be developed to ensure successful implementation of the APELL Programme for responding to emergencies.

Industry

- Industry's responsibility is to ensure that information known about the potential risk of chemicals is sufficient to enable users to develop proper risk management strategies. Appropriate and meaningful information (easily understood by all) needs to be disseminated to all stakeholders.
- To develop and implement the principles of product stewardship, the activities of all stakeholders in the chain of chemical manufacture and use need to be coordinated. Appropriate training programmes should be developed and implemented to ensure a proper understanding of the principles of product stewardship by all stakeholders in the chain.
- Training programmes need to be strengthened and implemented to ensure that workers are effectively trained with respect to understanding chemicals classification and labelling and the information contained in Material Safety Data Sheets.[16]
- Industry's Responsible Care initiative should be strengthened in regard to information dissemination and hazard communication.
- The principles of cleaner production and proper waste disposal should be promoted in industry.

Civil society

Civil society needs the capacity to ensure that it can participate effectively in processes related to chemicals management and can meet its obligations. Specifically, the roles of civil society include:

- undertaking independent research and evaluation concerning environmental issues;

- supporting citizens who need assistance in dealing with problems arising from the use of chemicals;
- promoting environmental issues for the benefit of all citizens;
- disseminating to the general public information that has been made available by the government and the industry sector;
- informing industry and government about any issues of concern to the general public.

Since the WSSD, South Africa's Chemical and Allied Industries' Association (CAIA)[17] has developed a strategy for extending Responsible Care along the value chain in response to some of the priorities identified above. A study is also being conducted to ensure that training activities are developed within the national skills development strategy. This strategy requires the development of sector skills plans for five-year periods. A review of training needs in chemical management is currently being undertaken to ensure that the required elements are included in the chemical sector skills plan for the period 2005-09 being developed.

Meeting stakeholder expectations: Responsible Care

The international Responsible Care initiative[18] is the global industry's commitment to continuous improvement in safety, health and environmental performance. It was adopted in South Africa in 1994. Although implementation of this initiative in South Africa has contributed to the improvement of chemical industry performance in this area, the industry has acknowledged that much still remains to be done.

The chemical industry recognizes its potential impacts on the environment, particularly on resource utilization. The Responsible Care initiative is implemented in South Africa through seven Management Practice Standards, covering:

- Health and Safety;
- Storage, Distribution and Transport;
- Pollution Prevention and Resource Efficiency;
- Community Interaction;
- Emergency Response;
- Product Stewardship and Process Safety.

Implementation of these standards is evaluated every two years. Quantitative Indicators of Performance are collected annually. An annual award is made to the company that has shown the most improvement in respect of these indicators.

The initiative provides a sound platform not only for improving compliance with environmental and health and safety legislation, but also for encouraging continuous improvement in performance beyond mere legal compliance. In the absence of comprehensive national legislation in the area of safety, health and the environment, Responsible Care provides a framework within which multinational companies can operate to the same standards as in their country of origin.

Poor safety, health and environmental practices cost more in the long term than introducing sound chemical management practices. One of the major challenges facing industry in many developing countries is how to operate plants at an appropriate standard without the support of a national framework. Market access issues increasingly include social and environmental considerations.

The ICCA report on the chemical industry's contribution to sustainable development, prepared for the WSSD under the auspices of UNEP, recognized the need to meet increasing demand from stakeholders for Responsible Care to address stakeholders' key areas of concern.[19]

To address this issue, the South African chemical industry undertook the development of a strategy to extend Responsible Care along the value chain.

The strategy was developed by assessing current chemical management practices. Information was collected through a process of interviewing key organizations and/or associations that represent the different stages in a chemical life cycle (i.e. raw material supply, primary chemical manufacture, secondary chemical manufacture, import/export, consumption/end-user, transportation, waste management). The chemical management instruments currently in use include:

- safety, health and environmental management;
- risk assessment;
- supplier-user agreements;
- provision of information and guidance for users;
- information management;
- development of safer products and processes;
- incident management;
- performance monitoring and review;
- import/export procedures;
- training and awareness raising;
- safe disposal of waste.

The results of the investigation confirmed that, to a greater or lesser extent, sound chemical management practices are generally in place for raw material suppliers, primary and secondary chemical manufacturers, and importers and exporters. However, these practices at best extend to downstream entities by only one link in the chemical chain.

The needs of consumers (the end-users of chemical products) and service providers (e.g. waste management firms and road hauliers) were identified by interviewing representatives in those areas. This group identified a range of priorities to help them manage chemicals more safely and increase their confidence in the chemical industry. These include:

- independent verification of the implementation of the Responsible Care initiative;
- a standardized approach to provision of hazard information;
- consistent use of chemical terminology;
- the need for a life-cycle approach;
- uniform procedures for handling of chemicals;
- training of users and awareness raising,
- improved comprehensibility of hazard information.

A strategy has been developed to improve implementation of Responsible Care in South Africa to address these issues. It includes the following elements:

- independent verification of implementation of Responsible Care;
- targeted marketing campaigns to raise awareness of the benefits of using Responsible Care companies as chemical suppliers and as service providers to the chemical industry;
- assistance to smaller companies in implementing Responsible Care;
- additional support to companies in implementing Responsible Care;
- training of chemical users.

Experience with implementting Responsible Care in South Africa has shown that performance in areas like worker safety (measured in terms of incident reports) has improved, as has the frequency of transport incidents.

By 2004 all Responsible Care signatory companies had established formal mechanisms to engage with communities near chemical plants.

The way forward

The three priority areas for sound management of chemicals discussed in this article reveal the complexity of the challenge that faces countries in developing sound strategies for chemicals management in ways that exploit the benefits of chemicals while ensuring that they are managed throughout their life cycle with minimum adverse effects.

The South African chemical industry is attempting to meet the challenges of moving towards a more integrated approach to chemical management by addressing the three areas described.

Responsible Care is being used as the platform for developing a more integrated approach by incorporating all elements of chemical management along the value chain into implementation of the initiative and independently verifying companies' performance.

Implementation of the GHS will be a departure point for better interaction with consumer groups in regard to disseminating more comprehensible information on chemical hazards.

The national strategy being developed for the chemical sector will support the integration of chemical management elements with economic and social objectives.

The need to integrate capacity building efforts in the national skills development strategy is recognized. The chemical industry is working with other stakeholders to ensure an integrated approach. Another important need is for international capacity building efforts to be aligned with national strategies for skills development.

Development of a Strategic Approach to International Chemicals Management (SAICM) provides a unique opportunity for national, regional and international agencies involved in the management of chemicals to consider ways in which much needed streamlining can become a reality.

The catalytic role this initiative can play in promoting a more integrated approach at national level is being explored. In addition, South Africa has recently been admitted to membership of the OECD's Good Laboratory Practice (GLP) initiative, leading to Mutual Acceptance of Data, which presents a further opportunity for better integration at national level.[20]

If the ideal of an integrated approach to chem-

ical management is to be achieved, all countries should exploit the opportunity presented by the SAICM initiative to ensure that chemical management is integrated into the economic imperatives of the developing world. A successful outcome to SAICM will be a strategic approach that recognizes the gains already made in this area and builds on them to address the gaps.

Notes

1. www.chem.unep.ch/saicm/prepcom1.
2. The Chemical Weapons Convention (CWC) is an international treaty that bans the use of chemical weapons and aims to eliminate chemical weapons, everywhere in the world, forever (www.opcw.org/index.html).
3. www.incb.org/e/conv/1988/cover.htm.
4. www.unep.org/ozone/Treaties_and_Ratification/2B_montreal%20protocol.asp.
5. www.pops.int.
6. www.pic.int.
7. www.who.int/ifcs/Documents/ Forum/ForumIII/f3-finrepdoc/Bahia.pdf.
8. www.ilo.org/public/english/protection/safework/papers/unorgact/ch1.htm.
9. www.unece.org/trans/danger/publi/ghs/histback.html.
10. www.wcoomd.org/ie/index.html.
11. www.uneptie.org/pc/cp/ncpc/home.htm.
12. unece.org/trans/danger/publi/ghs/officialtext.html.
13. www.unitar.org.
14. www.icca-chem.org.
15. www.uneptie.org/pc/apell.
16. See, for example, www.msdssearch.com.
17. www.mbendi.co.za/caia.
18. See, for example, www.icca-chem.org/rcreport.
19. www.icca-at-wssd.org/On_the_road.
20. The primary objective of the OECD Principles of Good Laboratory Practice (GLP) is to ensure the generation of high quality and reliable test data related to the safety of industrial chemical substances and preparations, in the framework of harmonizing testing procedures for the Mutual Acceptance of Data (MAD) (www.oecd.org/department/0,2688,en_2649_34381_1_1_1_1_1,00.html).

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The Montreal Protocol: lessons for successful international chemicals management

Summary

The Montreal Protocol on Substances that Deplete the Ozone Layer was designed to phase out the production and consumption of a number of CFCs and several halons. Adopted in 1987, the Protocol came into force in 1989. It has been amended to introduce other types of control measures and to add new controlled substances. The Protocol is an example of policy-making based on scientific, environmental and technological global assessments. Its successful implementation can provide lessons for policy- and decision-makers in governments and industry, as well as for international organizations implementing other international agreements concerning chemicals.

Résumé

Le Protocole de Montréal sur les substances qui appauvrissent la couche d'ozone avait pour objet de mettre progressivement fin à la production et à la consommation d'un certain nombre de CFC et de plusieurs halons. Adopté en 1987, il est entré en vigueur en 1989. Il a été amendé pour inclure d'autres types de mesures de réglementation et ajouter de nouvelles substances réglementées. Il constitue un exemple d'élaboration de politiques fondée sur des évaluations scientifiques, environnementales et technologiques mondiales. Le succès de sa mise en œuvre peut servir de leçon aux responsables politiques et aux décideurs des gouvernements et de l'industrie, ainsi qu'aux organisations internationales qui mettent en œuvre d'autres accords internationaux sur les produits chimiques.

Resumen

El Protocolo de Montreal sobre Sustancias que Agotan la Capa de Ozono fue diseñado para eliminar la producción y el consume de diversos CFC y halones. El Protocolo fue adoptado en 1987 y entró en vigor en 1989, y ha sido modificado a fin de incluir otros tipos de medidas de control y sustancias controladas. Constituye un ejemplo de formulación de políticas con base en evaluaciones científicas, ambientales y tecnológicas a nivel mundial. La exitosa ejecución del Protocolo puede servir como modelo para los responsables de la formulación de políticas y de la toma de decisiones dentro del sector gubernamental e industrial, así como para los organismos internacionales responsables de la ejecución de otros convenios internacionales sobre sustancias químicas.

In 1974 two American scientists, Mario Molina and F. Sherwood Rowland, published an article in the scientific journal *Nature* in which they hypothesized that chlorofluorcarbons (CFCs) survive long enough in the atmosphere to reach the stratospheric ozone layer (which limits the amount of ultraviolet radiation reaching the earth's surface). There, according to the authors, the CFCs are decomposed by ultraviolet radiation. This liberates chlorine, which is implicated in the thinning of the ozone layer.

Production of CFCs in the mid 1970s was soaring. The article by Molina and Rowland created a storm among scientists and the producers of these chemicals.[1]

In the mid 1980s the British Antarctic Survey confirmed that severe depletion of the ozone layer was occurring (the phenomenon which became known as the "ozone hole"). The link between CFCs and the Antarctic ozone hole was soon established using satellite measurements.[2]

Until then, it was generally considered that only toxic and hazardous chemicals needed to be managed. The rude surprise was that using non-toxic, apparently harmless chemicals like CFCs could indirectly cause catastrophes.

International efforts to respond to these discoveries were initiated by UNEP in 1977 through the World Action Plan on the Ozone Layer. In 1987 the Montreal Protocol on Substances that Deplete the Ozone Layer was signed.[3] The Montreal Protocol's overall objective is to protect the ozone layer by limiting the use of ozone depleting substances (ODS) including, but not limited to, CFCs.

Several regional and global treaties whose purpose was to manage toxic or hazardous chemicals predate the Montreal Protocol (**Table 1**). All of these treaties were aimed at preventing and managing the direct risks of such chemicals.

The Montreal Protocol has become a flagship global treaty. It is now accepted that all man-made chemicals, toxic and hazardous or otherwise, require strategic management.

Key elements of the Montreal Protocol

A science-based precautionary approach

Successful implementation of the Montreal Protocol has established a trend towards policy-making based on global scientific, environmental and technological assessments. In 1987 the Protocol did not call for the complete elimination of production and consumption of CFCs and halons.[4] Based on subsequent global assessments, however, the Parties to the Convention have agreed to the phase-out of these substances, along with tightened control measures and accelerated phase-out schedules.

Since 1989 a network of experts from nearly 40 countries has worked together on UNEP's Scientific Assessment Panel,[5] Environmental Assessment Panel[6] and Technology and Economic Assessment Panel.[7] They regularly produce reports and interpret (on a consensus basis) their observations and findings.

Progressive listing of chemicals

The Parties to the Convention have agreed to eliminate the production *and* consumption of ozone depleting chemicals. A short initial list has expanded to include 96 chemicals and their 576 isomers. About 16 of these chemicals are widely used.

Slowly but steadily: eliminating production and consumption

The Parties might have agreed to eliminate production only. However, a number of countries imported these chemicals from producing countries for uses such as air conditioning and refrigeration, electronics manufacturing, fire-fighting and agricultural production (**Table 2**). It was of critical importance that sectors in which ODS were consumed underwent a smooth transition through the adoption of alternate technologies.

During negotiations on the Protocol, the Parties have demonstrated their commitment to move forward – but always with prudence. Policy-makers have shown foresight in decisions based on scientific assessments and observations provided by the Scientific Assessment Panel. Another consideration has been the rate of introduction of alternative technologies and alternative chemicals, provided by the Technology and Economic Assessment Panel. The conclusions of the Environmental Effects Panel concerning projected impacts of ozone layer depletion have also been taken into account.

Participation by developing countries: common but differentiated responsibilities

The Montreal Protocol was the first international agreement to recognize the common but differentiated responsibilities of industrialized and developing countries with respect to global environmental problems. In 1985 industrialized countries accounted for 85% of world consumption of ODS. These countries took the lead in phasing out ODS. They also approved a grace period for developing countries implementing control measures. In addition, they agreed to contribute to a Multilateral Fund to meet the extra costs that would be borne by developing countries in phasing out ODS.

The Parties recognized that dissemination of alternative technologies would be the key to the Protocol's successful implementation. Therefore, they provided for the transfer of such technologies to developing countries and the strengthening of these countries' capacities to adopt them.

The Financial Mechanism was agreed in 1990. The Multilateral Fund (part of the Financial Mechanism) was created in 1991. It is managed by an Executive Committee of 14 Parties, seven each from industrialized and developing countries, appointed annually by the Meetings of the Parties. The Fund Secretariat in Montreal assists the Executive Committee. The implementing agencies for the Fund's programmes in developing countries are UNEP, the United Nations Development Programme (UNDP), the United Nations Industrial Development Organization (UNIDO) and the World Bank.[8]

Table 1
Some regional and global agreements concerned with chemical management before the Montreal Protocol

- Convention 13 of ILO: Use of White Lead in Painting (1921)
- European Agreement concerning the International Carriage of Dangerous Goods by Road (1957)
- Convention 136 ILO: Protection against Benzene (1971)
- Convention for the Prevention of Pollution from Ships (1973)
- Convention 139 of ILO: Prevention and Control of Occupational Hazards by Carcinogenic Substances (1976)
- Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (1976)
- Kuwait Regional Convention on the Protection of the Marine Environment from Pollution (1978)
- Convention on Long-Range Transboundary Air Pollution (1979) and related Protocols
- Convention for Cooperation in the Protection and Developments of the Marine and Coastal Environment of West and Central Africa (1981)
- Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific (1981)
- Regional Convention for the Conservation of the Red Sea and Gulf of Aden (1982)
- Protocol on Long-term Financing of the Cooperative Programmes for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (1984)
- Convention for Protection, Management and Development of the Marine and Coastal Environment of the Eastern Pacific Region (1985)
- Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30% (1985)
- Noumea Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (1986)

What has been achieved so far: global participation

The Montreal Protocol's first and most significant achievement has been the level of global participation (**Figure 1**). There are now 187 Parties to the Convention, representing nearly all of humanity.[9]

Progress in phasing out ODS

Industry has provided alternative substances and technologies for almost all ODS uses. To meet the provisions of the Protocol, industrialized countries have phased out consumption of a million tonnes of CFCs since 1986 (**Figure 2**). They now consume about 11,000 tonnes for essential uses approved by the Meetings of the Parties. Most of these uses are in medical aerosols for which alternatives are not yet unavailable.

The abundance of CFCs and other ODS in the atmosphere has been measured regularly since about 1978. Annual growth in abundance has increased over much of this period, but data show that in recent years increases are slowing for many ODS and that the abundance of some ODS is actually decreasing. These measurements clearly indicate the Protocol's success.

Progress in developing countries

The Multilateral Fund has financed nearly 5000 projects in 134 developing countries over the past 13 years, at a cost of approximately US$ 1.7 billion. Projects include a wide range of technology transfer activities involving investment projects that focus on refrigeration, aerosols, fire extinguishing, metal cleaning, foams and other uses. Projects approved through 2002 have resulted in the elimination of over 180,000 tonnes of ODS in developing countries (**Figure 3**).

The Multilateral Fund is one of the best-subscribed funds within the United Nations. More than 85% of contributions are made on time. Countries in arrears are mainly from the former Soviet Union. Developed countries have pledged US$ 474 million for the 2003-2005 triennium.

Assistance has been approved for the phase-out of CFCs production in India, and of CFCs and halons production in China.

Emerging issues

Although the Montreal Protocol can be seen to serve as a pilot for other international conventions, full-scale success has not yet been achieved. Several emerging issues still need to be addressed:

- Developing countries are now the greatest ODS producers and consumers. Their commitment and participation are essential;
- Illegal trade in CFCs is proliferating in Europe and the United States;
- There are still loopholes and omissions in the Protocol concerning:
  - methyl bromide quarantine and pre-shipment exemption;
  - lack of control measures regarding the phase-out of production of hydrochlorofluorocarbons (HCFCs);
  - slow progress on alternatives to metered dose inhalers (MDIs);
  - lax interpretation of controls on process agents;
  - lack of a mechanism to implement the recommendations of the HFC/PFC task force of TEAP;[10]
- Linkages between international conventions (e.g. the Montreal and Kyoto Protocols) are reappearing as a key focal element. Today linkages may seem to be an academic issue, and impacts such as those of HFCs and PFCs may appear insignificant. Yet these linkages may prove important to ultimate success.[11]

Lessons for strategic management of chemicals

There are a number of signs that the Montreal Protocol is achieving its objectives. Ratification is now nearly universal. More than a million tonnes of CFCs per year and another million tonnes of carbon tetrachloride (CTC) and methyl chloroform have been phased out by industrialized countries. Developing countries are half-way through phasing out these substances, well on target according to the terms of the Protocol.

Chlorine loading in the stratosphere – the cause of ozone layer depletion – is slowing. Scientists predict that the ozone layer could fully recover by the middle of this century if other factors such as climate change do not affect this recovery. Cooperation between industrialized and developing countries has been extremely effective. Industrialized countries have been assisting developing ones without interruption during the past 12 years. More than 100 different technologies using ozone-friendly chemicals have been transferred to developing countries. Financial assistance to these countries has been over US$ 1.7 billion.

Nevertheless, the Protocol's success has not been without frustrations, disappointments and dilemmas. A number of challenges continue to pose questions to which there are no easy answers.

Table 2
ODS uses

	Refrigerant	Fire extinguishing	Solvent	Foam blowing	Process agent and feedstock	Pesticide	Aerosol
CFC-11	✔		✔	✔	✔		✔
CFC-12	✔			✔			✔
CFC-113			✔		✔		
CFC-114	✔						✔
CFC-115	✔						✔
HCFC-22	✔						✔
HCFC-123	✔						
HCFC-1416			✔	✔			
HCFC-1426			✔	✔			
Halon-1211				✔	✔		
Halon-1301	✔	✔					
Halon-2402		✔					
CTC		✔		✔	✔		
Methyl chloroform			✔		✔		
Methyl bromide					✔	✔	

Softening the strategy: dependence on transitional chemicals

Under the Protocol, production and consumption of hydrofluorcarbons (HCFCs), which have a lower ozone depletion potential (ODP) than CFCs, has been permitted for a longer period than in the case of CFCs. This has allowed more time for the development and commercialization of zero-ODP technologies. HCFC use continues to grow, particularly in developing countries. While consumption of HCFCs has a marginal impact on ozone layer recovery, its impact on climate change may not be marginal in view of these chemicals' global warming potential. The final phase-out of HCFCs is scheduled for 2040.

Ozone-friendly – yes, but climate-friendly?

Hydrofluorcarbons (HFCs) have emerged as zero-ODP alternatives to CFCs. However, they possess very high global warming potential. Use of this family of chemicals solves one environmental problem, but presents another.

Protect the ozone layer – yes, but what will be the impacts on agricultural production?

2005 was the year for phase-out of methyl bromide in industrialized countries. This ODS is a fumigant used to improve crop yield and for post-harvest protection and quarantine treatments. Because of the lower efficacy of methyl bromide alternatives, a large number of exemptions ("critical-use exemptions") have been granted to developed countries. During negotiations, many considered that such exemptions dilute governments' commitments under the Protocol. Many alternatives to methyl bromide, even if they are zero-ODP, are more toxic than this chemical.

Strict environmental regimes encourage illegal trade of chemicals

The more stringent the controls, the more active the ODS smugglers are. A steep tax on ODS in the United States resulted in higher market prices. This stimulated the introduction of relatively less expensive alternatives, but also provided incentives to smugglers and resulted in an increase in illegal ODS trade. Training of customs officials and border police has helped to arrest this trend, but the challenge remains.[12]

The new generation of ozone depleting chemicals

As the race to phase out ODS has continued, alternative chemicals such as bromochloromethane and n-propyl bromide (nPB) have emerged. These substances have been assessed as having ODP. Policy-makers consider that "prior assessment" may prevent the emergence of a new generation of ozone depleting chemicals.

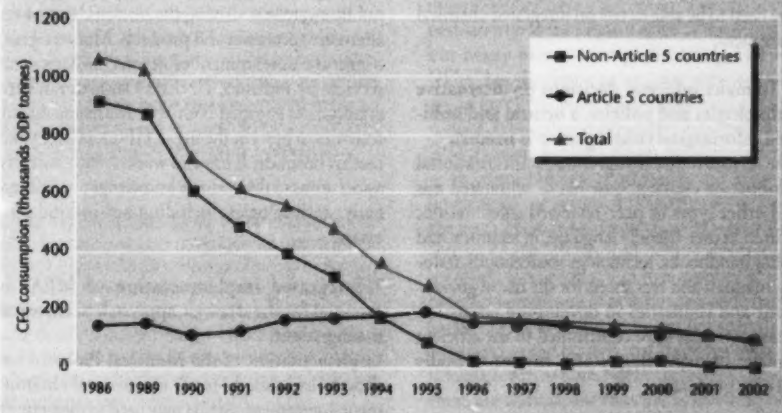
Lessons from the Protocol's implementation

Since the purpose of the Montreal Protocol is to protect the stratospheric ozone layer, it falls into the "atmosphere cluster" category. It also falls into the "chemical cluster" category since activities aimed at meeting its objectives entail chemicals management. Policy- and decision-makers in governments

Figure 1
Progressive ratification of the Montreal Protocol

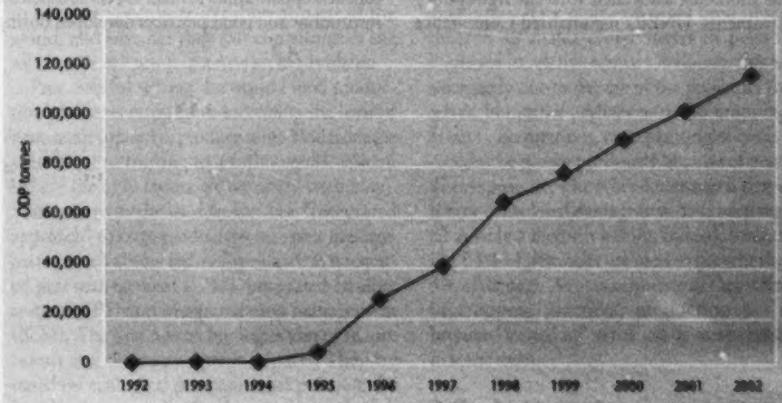
Source: Ozone Secretariat web site at http://www.unep.org/ozone/index.asp

Figure 2
World CFC consumption trend, 1986-2002[14]



Source: Article 7 data reported by the Parties to the Ozone Secretariat (aggregated by OzonAction)

Figure 3
Phase-out of ODS consumption through Multilateral Fund projects, by year of actual completion



Source: Inventory of projects funded by the Multilateral Fund for the Implementation of the Montreal Protocol

and industry, as well as international organizations engaged in work related to implementing other multilateral environmental agreements (MEAs) on chemicals, can draw relevant lessons from the Protocol's implementation. For example:

1. Each country needs its own strategy to manage chemicals. Such strategies need to be developed and implemented by a participatory approach at the national level.
Using a participatory approach, UNEP's OzonAction Programme[13] has assisted 100 developing countries to develop a strategy ("Country Programme") for managing and eliminating ODS. The participatory approach results in country ownership, which contributes to efficient implementation. Nearly all of these countries have been successful in complying with the Protocol.

2. Integrated assessment of chemicals is needed to evaluate their overall impact and management.
Ozone-friendly chemicals may not be climate-friendly. They may not be less toxic or less polluting than other chemicals, nor do they necessarily promote energy efficiency. Policy-makers therefore need to be able to rely on integrated chemical assessment.

3. To make informal decisions on alternative technologies and policies, a neutral and unbiased information clearinghouse is needed.
The OzonAction Programme's international information clearinghouse has disseminated this and other types of peer-reviewed information, written in user-friendly language, in technical and policy handbooks, technology sourcebooks, training manuals and fact sheets for the use of government and industries in developing countries. These activities have contributed to the efficient transfer of technologies and environmentally friendly practices.

4. Project development and implementation alone may not fully address chemical management needs.
Experience with the Montreal Protocol demonstrates that projects alone are not sufficient to manage chemicals. To sustain their impact, projects should be associated with the right policy instruments. UNEP's regionalized Compliance Assistance Programme (CAP) provides essential policy assistance to developing countries through direct contact with governments.

5. Regional delivery of assistance is key to the success of chemical management.
International Implementing Agencies need to rationalize their assistance, and to provide assistance through national focal points under the Multilateral Fund of the Montreal Protocol. UNEP has regionalized its capacity building assistance. Through regional offices in Bangkok, Nairobi, Bahrain and Mexico City, 45 expert UNEP staff are in direct contact with more than 140 developing countries. Regional and thematic meetings facilitated by UNEP in informal settings help with sharing of technical and policy information. Participation in such meetings by industrialized countries makes possible north-south dialogues to supplement south-south cooperation.

6. In awareness raising and the deployment of alternative technologies, it is as important to engage with industry as with NGOs.
NGOs provide a much-needed "torchlight" for public awareness, driving the market demand for alternative processes and products. Market signals trigger the development of new technologies and services by industry. UNEP's OzonAction Programme has engaged NGOs in awareness-raising activities to prevent the use of HFCs, HCFCs and methyl bromide. It has also worked with industry associations to disseminate knowledge about alternative technologies, including not-in-kind processes.

7. Integrated implementation of MEAs is essential for the strategic approach to chemical management.
Implementation of the Montreal Protocol has shown that a single-focus multilateral environmental agreement (MEA) may need to integrate its activities with those of other MEAs. Integrated implementation at the national level of the Basel Convention, the Stockholm and Rotterdam Conventions and the Montreal Protocol will contribute to the Strategic Approach for International Chemical Management (SAICM). The Montreal Protocol offers opportunities to make use of the expertise, institutions and good practices developed during its implementation in addressing challenges related to the international chemical agenda.

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Notes

1. The authors' calculations, widely contested at the time, were correct in all essentials. They shared the 1995 Nobel prize for chemistry with Paul Crutzen of the Netherlands; each of these three scientists carried out pioneering work on ozone formation and decomposition.
2. Data from satellite monitoring was at first automatically discarded by NASA's computer as not being credible. We now know that the ozone layer is also being depleted over the Arctic.
3. www.unep.org/ozone/Treaties_and_Ratification/2B_montreal%20protocol.asp.
4. Halons have been widely used in fire extinguishers. Very stable and unreactive, they are up to ten times more destructive of ozone than CFCs.
5. www.unep.org/ozone/faq-science.shtml.
6. www.unep.org/ozone/faq-env.shtml.
7. www.teap.org.
8. www.unmfs.org.
9. There are 191 UN Member States (www.un.org/Overview/unmember.html).
10. In 1998 the Parties to the Convention requested the Protocol's Technology and Economic Assessment Panel (TEAP) to assess the implications of the inclusion of hydrofluorcarbons (HFCs) and perfluorocarbons (PFCs) in the 1997 Kyoto Protocol to the UN Framework Convention on Climate Change. See *The Implications to the Montreal Protocol of the Inclusion of HFCs and PFCs in the Kyoto Procol* (www.unep.org/ozone/HFC-PFC-Rep.1999/index.shtml).
11. See, for example, *The Implications of the Inclusion of HFCs and PFCs in the Kyoto Procol*, ch. 5 and *passim*.
12. See the article on Green Customs, page 58.
13. www.uneptie.org/ozonaction.
14. Article 5 countries are eligible for assistance under the Financial Mechanism, which includes the Multilateral Fund (www.uneptie.org/ozonaction/ compliance/protocol/article5.html. ◆

The future of pesticide use in world agriculture

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Summary

How can enough food be produced without compromising agriculture's long-term sustainability? Numerous ways to mitigate the impacts of conventional agriculture (which makes use of chemical pesticides and fertilizers) while meeting production objectives have been proposed. Good results have been achieved with technologies like integrated pest management (IPM), which aims to minimize the use of pesticides, and with changes in their use associated with the introduction of genetically modified crops. This article examines the impact that various technologies are likely to have on agriculture in different parts of the world. It also looks at whether these technologies can contribute to the solution or will result in a new set of problems.

Résumé

Comment produire suffisamment de denrées alimentaires sans compromettre la viabilité à long terme de l'agriculture ? De nombreux moyens ont été proposés pour atténuer les effets de l'agriculture classique (consommatrice de pesticides et d'engrais chimiques) tout en atteignant les objectifs de production. De bons résultats ont été obtenus avec des technologies comme la lutte intégrée contre les ennemis des cultures (IPM) qui vise à réduire la consommation de pesticides, ou avec de nouvelles méthodes d'utilisation des pesticides conjuguées à l'introduction de cultures génétiquement modifiées. L'article étudie les effets que diverses technologies pourraient avoir sur l'agriculture dans différentes parties du monde. Il se pose également la question de savoir si ces technologies aideront à se rapprocher d'une solution ou créeront de nouveaux problèmes.

Resumen

¿Cómo producir alimentos en cantidades suficientes sin comprometer la sostenibilidad de la agricultura en el largo plazo? Se han propuesto diversas opciones para mitigar los impactos de la agricultura convencional (en la que se emplean pesticidas y fertilizantes químicos) al tiempo que se cumplen las metas de producción. Se han obtenido resultados positivos gracias a tecnologías como el manejo integral de plagas (IMP), cuyo objetivo es reducir al mínimo el uso de pesticidas, y gracias a los cambios realizados en su aplicación durante la introducción de cultivos genéticamente modificados. Este artículo analiza el impacto potencial de diversas tecnologías en la agricultura alrededor del mundo. Además, estudia la posibilidad de que dichas tecnologías contribuyan a solucionar el problema o causen dificultades hasta ahora desconocidas.

More than 842 million people are chronically hungry in the world today, with the prospect of another 2 billion to feed over the next 30 years or so (FAO 2004). Agriculture, in both the South and the North, will have to provide this food. Theoretically the food required can be produced using conventional agricultural practices over an expanded production area, although problems of equitable distribution will remain. Conventional agriculture (here taken to mean agriculture using synthetic agrochemicals to maximize production and economic benefit) produces its own set of problems, however, ranging from use of finite resources to detrimental health impacts and environmental pollution. In its most extreme forms, conventional agriculture is not sustainable.

How can sufficient food be produced to feed the world's population without compromising agriculture's long-term sustainability? Over the years a number of different approaches have been suggested to mitigate the impacts of conventional agriculture while meeting production objectives. These approaches have achieved varying degrees of success. The aim of this article is to explore the impact various technologies are likely to have on agriculture in different parts of the world, and whether they can contribute to the solution or will result in a new set of problems.

Proposals for solving the world's food production problems range from increasing the level of man-made inputs (to produce more food from the same area) to moving to a fully organic system (where the only inputs are naturally-occurring). Somewhere in the middle lies the "integrated approach" to crop production and pest management, which covers technologies such as integrated pest management (IPM), integrated farming systems (IFS) and integrated crop management (ICM). The first two technologies aim to reduce inputs and their subsequent impacts. They are based on ecological principles that promote the health of crops and animals, and that make full use of natural and cultural control processes and methods (e.g. host resistance and biological control). Chemical pesticides are used only where and when the above measures fail to keep pests below damaging levels. Interventions are made in the least damaging way and on the basis of sound economic returns. Integrated crop management does not necessarily have pesticide reduction as its key objective, but the aim is to minimize pesticide use and integrate cropping with farms' wider environmental management.

IPM has been developed over the past 40 years or so. During that period a number of different interpretations have come about. The one above is perhaps true to the original spirit of the definition, but many others are equally valid. The term "IPM" has also been used to cover approaches that are in fact little more than supervised pesticide control. It is (rather confusingly) quite possible for IPM to mean different things to different people.

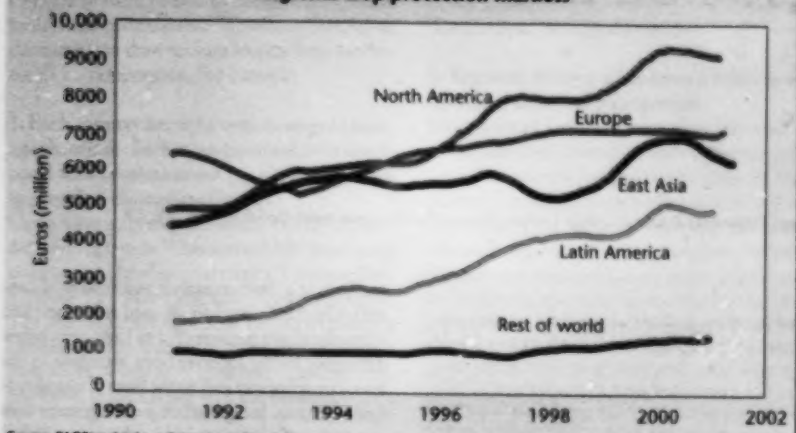
To postulate where agricultural production may be going in the future, it is instructive to look at the past. There is no doubt that the Green Revolution of the 1970s and 1980s dramatically increased food production in a number of countries through the use of new varieties and chemical inputs. If pesticide use in the last ten years or so is examined, it can be seen that there has been continued growth in both North and South, although there are indications that use is levelling off or declining in some regions (**Figures 1 and 2**). It would be nice to think that a levelling off or reduction in use was coming about through a shift to lower inputs in general, but the variation is probably also due to changes in the prices of crops and of the inputs themselves.

Paradoxically, over the period in which pesticide inputs have increased it has been observed that, in all major crops, losses to pests have increased in relative terms. Obviously, this is not necessarily due to the use of the pesticides themselves, but rather perhaps to mono-cropping, to fewer or no rotations, or to planting of crops that couldn't be grown previously because of pest and disease pressure. The other dimension is that what is now considered damage may have been regarded as only a blemish before; indeed, something like 95% of pesticides are used to prevent the last 5% of damage. As a consequence of these changes in cropping practices, production has now become "locked in" to the use of these chemicals in some cases.

Policy instruments

The negative impact of pesticides has been well-

Figure 1
Regional crop protection markets



Source: FAOStat database (http://apps.fao.org)

documented in the last 30 years. It is clear that excessive or careless use (even careful use in some cases) can cause environmental pollution and result in damage. A number of governments around the world have tried, or are trying, to reduce the quantity of pesticide used through new regulations, taxation or voluntary controls. It is worth looking at a couple of schemes in operation in Denmark (see box) and Sweden to gauge their success and whether they could suggest a model for the future. In Sweden multiple approaches were used to reduce pesticide use. First, a review of all products was made and many older products were withdrawn from use on environmental or health grounds. It was found that many of the newer pesticides could replace a lot of the older ones, as they were as effective but generally had less impact on the environment. Taxes were used from 1986 to influence the purchase of pesticides; the tax rate is currently 20 Swedish krona per kg of product. A training programme accompanied regulation, with all farm workers being trained and demonstration farms being set up to show farmers that reduced inputs could still be economical. Between 1986 and 1993, there was a 65% reduction in pesticide use as measured by weight of active ingredient.

These two examples of efforts to encourage minimal pesticide use through regulation and the development of new technology (in terms of new varieties, application technology and decision support for that transition) could be considered to represent a good approach to working towards true IPM.

In 1993 the United States government (through its various agencies) called for a national commitment to implement IPM on 75% of the country's crop area by the year 2000. In 2002 the Department of Agriculture (USDA) carried out a survey which revealed that IPM was used on 70% of crop area. It would appear that the goal was close to being achieved. However, according to estimates by the Consumers Union, the true figure was actually closer to 4-8% of the crop area. The difference results from the interpretation of what IPM is – or is not. In much of the area included by the USDA there is little more than supervised control, with pesticides being applied when monitoring indicates that they should be. Pesticide use is often the primary or only tactic, and therefore the system cannot truly be described as IPM since it is not integrated with anything else. Indeed, since 1992 pesticide use has increased by some 18,000 tonnes.

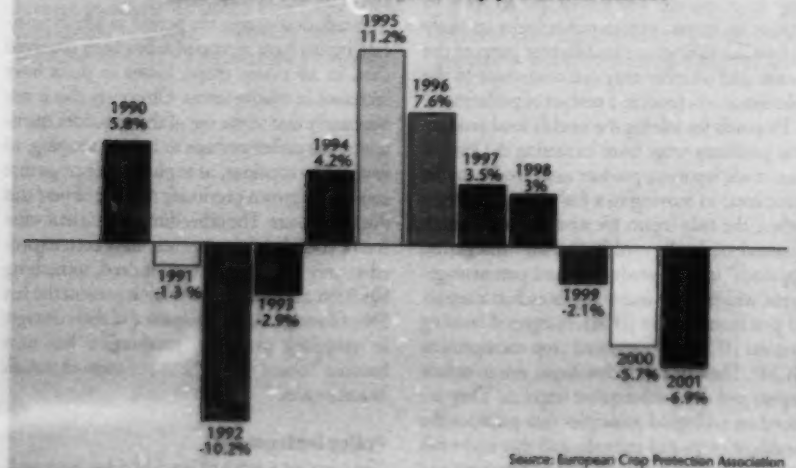
While it is true that supervised control is better than the alternative of calendar spraying, it is far from ideal. It is not surprising, perhaps, that IPM has not pervaded the industry and become the major tactic in the US and Europe; it is a very knowledge-intensive operation, it can be expensive to implement with respect to manpower, and vast amounts of research are needed in order to provide information to make it work. While it is possible to do all of this, the alternative of sticking with simple chemical control is much more attractive since it gives reliable results and is not terribly expensive for the individual grower.

Use of supervised control and IPM has brought about huge reductions in pesticide use in many areas, but there is significant improvement to be made in many others. There is also a need to reduce agriculture's impact on the environment and to make it sustainable. As an illustration of some of the gains that have been made, an IPM programme for Texas cotton resulted in pesticide applications being reduced by 71% with a small reduction in yield. The net profit of the IPM farms was US$ 81.50 per acre, against a loss of US$ 105 per acre in the case of conventional farming. The majority of farmers in this programme used scouting to find the pests, alteration of the date on which the crop was sown and different sowing rates. They considered natural enemies in making their decisions.

Elsewhere in the world the uptake of IPM follows similar lines. If a very lenient definition of IPM is used, the uptake in Europe approaches similar levels to those in the US, i.e. around 70% of land area. A rather stricter definition reveals that large areas are now farmed with reduced rates of pesticides, but that rather fewer actually practise integration of all possible tools available. The reduction in pesticide use is to be welcomed. However, there is still room for significant improvement. For example, the Less Intensive Farming and Environment project funded by the UK government shows that over a five-year rotation a low input regime produced yields some 10-15% less than conventional farming. But it did so with savings of 33-35% on inputs and a gross margin that was the same or 2% greater than conventional. The prospects for pesticide-free glasshouse (greenhouse) production in Europe are improving, and orchard crops are being managed with good IPM principles.

Use of IPM tactics and training has yielded many benefits to farmers in Southern countries. Farmer field schools in Asian countries such as Indonesia, the Philippines and Viet Nam have resulted in marked reductions in pesticide use on rice crops. In Indonesia a million farmers have reduced their sprays from three to one per sea-

Figure 2
Real growth in the European crop protection market



Source: European Crop Protection Association

Danish Pesticide Action Plans

The first Danish Pesticide Action Plan was developed in 1986, with the objective of reducing pesticide use by 50% before 1997 (measured in both tonnes of active ingredient and frequency of treatment). This plan did not include any effective proposal. It was largely opposed by farmers. Consequently, treatment frequency was reduced by only 8% although the switch to low-dose pesticides resulted in a 47% reduction in the weight of active ingredient. The government also reviewed all pesticide registration. As a result, only 78 of 213 chemicals were approved for use. In 1996 the government introduced a pesticide tax, which was set at 54% of the price for insecticides and 33% for herbicides and fungicides. Revenue from the tax is used for research into the effects of pesticides (25%) and reducing land taxes for the farmers.

In 1997 the Bichel Committee was set up to assess the impact of phasing out pesticides from agriculture. Their report showed that the use of pesticides could be reduced from a frequency treatment index (the number of pesticide applications made to the crop each year) of 2.45 to between 1.4 and 1.7 within a five- to ten-year period, without serious financial or socio-economic impacts on farmers. The Second Pesticide Action Plan, announced in 2000, has the following goals:

- treatment frequency index as low as possible on treated acreage;
- protection of certain areas, including a buffer zone along targeted watercourses and lakes of over 100 m^2;
- an increase in the acreage of organic production;
- revision of the pesticide approval scheme.

This would be accomplished by:

- increasing advice to farmers on how to reduce pesticide consumption;
- establishing demonstration farms and information groups;
- increasing the use of decision-support and warning systems for diseases and pests;
- introducing targets for use of pesticides in different crops as a control instrument at farm level;
- using set-aside (i.e. taking land out of production) and increased and improved research programmes on pesticide pollution.

The plan had a rapid effect, with the frequency index dropping below 2.0 by 2000. It revealed to some farmers that they were using too many applications. Interestingly, many farmers were using much lower levels than average and still maintaining profitability. Experiments have shown that in winter wheat the highest profits were achieved with a treatment frequency of only 1.2.

One reason cited for the success of the plan is that farmers and pesticide organizations were involved in its development.

Despite the 1998 increase in taxes, prices of pesticides have increased by only 4% since 1997. The prices of insecticide, which was subject to the greatest tax increase, have even fallen by 6%. The taxes have failed to impact greatly on the price of pesticides, but due to the drop in crop prices the relative prices of pesticides have increased by 50-60% compared to that of corn. Thus a change in market conditions has probably had a greater impact on pesticide use than taxation itself.

son. In Viet Nam 2 million farmers have similarly reduced their use of pesticides. In Sri Lanka 55,000 farmers have reduced the number of sprays from three to 0.5 per year. In each case the yield has been maintained and there are savings due to lower input costs. In some areas the programmes have been so successful that it is reported that 25% of farmers in Indonesia, 20-33% in Viet Nam's Mekong Delta and 75% in parts of the Philippines are growing rice without any pesticides at all. This provides the opportunity to combine fish farming with rice growing, providing additional, valuable protein to farmers.

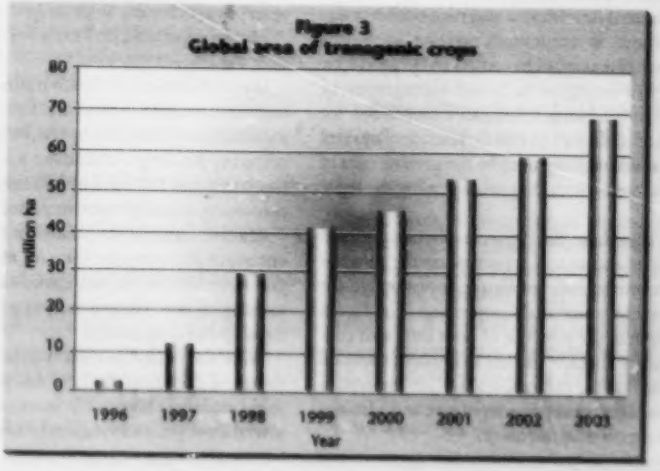
Organic production

The market for organic food is growing rapidly in many Northern countries and so is the area under this form of production although in developed countries the total area under organic farming is only around 1% of crop area. Organic production generally has very much lower impacts on the environment than conventional farming, but yields also tend to be lower when moving from high-input systems (typically of the order of 30%). When converting from low-input agriculture, as occurs in many Southern countries, there is either no drop in yield or a slight increase. In both cases the practice is generally more sustainable, in that there are significantly lower levels of pollution and soil erosion. The current area of registered organic land is small, but in West Africa it is estimated that over one-third of agricultural produce is grown organically. It is also estimated that about 60 million hectares is farmed organically in South and East Africa. The demand for organic produce is outstripping supply. Demand for this type of production will probably determine how the industry will develop.

In many developed countries the cost of transition is very high and subsidies are needed to achieve it. Organic production still allows the use of natural pesticides to control pests and diseases. It could be argued that some of these pests and diseases would be rather more environmentally damaging than the conventional alternatives, so that care needs to be exercised in their use.

Agriculture can proceed along a number of routes to provide food and livelihoods to people in a sustainable way in the future. All of these routes will be influenced by changes in technology that will have small or great effects on production. A number of changes are already being made, with new technologies being used to reduce pesticide use through precision farming, patch spraying and new application methods. New chemicals (often based on natural substances) that are more specific and less environmentally damaging are coming on the market and reducing the impact of conventional pesticide use. New varieties with resistance to pest and diseases are being bred and adopted by growers in many parts of the world. Research on how best to use existing technologies is also advancing and will lead to improvements in production levels. Although all these changes will improve food production, the improvements will generally be small. Major improvements are only really likely to come from major changes in technology such as biotechnology.

Figure 3
Global area of transgenic crops



Agricultural biotechnology

The benefits of biotechnology are derived from its potentially large contribution to gains in productivity and quality. These may come from increased yields, reduced use of pesticides and/or fertilizers, reduced labour requirements or better nutritional quality. Ultimately, higher production should lead to lower prices and therefore better access to food for the world's poor. If the rural poor can be raised above current poverty levels, there are potentially real gains to be made. Increases in production do not come without associated risks and uncertainties, and there are still many questions left to answer about genetically modified crops and other genetically modified organisms.

The current range of genetically modified crops has been developed in Northern countries for the agricultural systems operating there. The main thrust has been to produce crops that are herbicide-tolerant (allowing simplified weed control) or that contain insecticides to confer protection against a range of pests, or both of these traits. This fits with current practices and has produced encouraging results in many countries. The technology itself is being adopted very rapidly, with the global area growing from 1.7 million hectares in 1996 to 67.7 million hectares in 2003 (Figure 3).

The benefits from biotechnology could be enormous. It has the capacity to speed up breeding programmes, create crops that are resistant to pests and disease, improve the nutritional value of crops, and provide crops that can survive and thrive in hostile environments. Delivering these benefits relies on the technology being presented to end users in an appropriate form, at an acceptable price and with the knowledge and skills required to utilize the technology. These are not dissimilar to requirements for conventional crop management. Therefore, many of the problems with implementing existing technologies may well apply to biotechnology. It may be that genetically modified crops are easier to distribute, as the seeds will contain the trait and there will be no need to apply additional components as there was in the first Green Revolution. However, this requires a reliable distribution network, which is often lacking in the countries that most need to improve production.

If the potential benefits are examined, it can be seen that they are potentially wide-ranging. The following examples show how GM technology can be applied to specific agricultural problems.

Pest resistance

Specific resistance to a particular pest is obviously beneficial to farmers. They will either be able to grow the crop where they couldn't before, or be able to reduce the amount of pesticide that they use to control it. Crops containing insect resistance genes from *Bacillus thuringiensis* confer protection to a range of lepidopterous pests. This has significantly reduced the quantity of insecticide used in cotton crops in the United States, where 1million kilograms less insecticide was used in 1999 compared with 1998. Reports indicate that the introduction of Bt cotton into China has reduced the number of sprays from 20 to seven per season in many parts of the country. However, there are reports that some farmers still spray up to 22 times even if the modified crop is being grown. Whether this technology can be trans-

Mexico's success in eliminating chlordane within a regional cooperation framework

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A well-known group of chemicals are classified as persistent organic pollutants (POPs).[1] Their properties include high toxicity, persistence in the environment, long-range transport in the atmosphere, and accumulation in fatty tissue. Direct contact with POPs can result in acute effects; accidents with POPs used as pesticides, for example, have killed agricultural workers or made them seriously ill.

Chlordane, a pesticide classified as a POP, was widely used in the past to control insect pests in crops and forests. It also had domestic and industrial applications, including termite control in wood and wood products. It has been designated a probable human carcinogen. High levels can damage the nervous system or liver. Chlordane is also known to affect the endocrine system and digestive system. It can cause behavioural disorders in children exposed before birth or while nursing.

Exposure to chlordane may occur due to eating contaminated foods or exposure to contaminated soil. It has been shown to be toxic to non-target species, including birds, fish, bees and earthworms.

Member countries of the Intergovernmental Forum on Chemical Safety (IFCS) agreed that there was sufficient evidence to warrant international action on POPs, including chlordane (IFCS/Forum-II/97). This was the basis for a decision of the UNEP Governing Council in January 1997 to the effect that a legally binding international instrument for the control of POPs should be developed.

Development of a Regional Action Plan

Chlordane was originally introduced into Mexico and many other countries for extensive use in agriculture. In recent years, however, use of this pesticide has been limited to termite control in certain wood products. Chlordane use was one of the first targets of the Sound Management of Chemicals (SMOC) initiative of the North American Commission for Environmental Cooperation (CEC). In 1997 a North American Regional Action Plan (NARAP) on chlordane was approved by the governments of Mexico, Canada and the United States, with the goal of phasing out registered uses by 1998.

In developing a NARAP for chlordane, the Parties involved committed to ongoing cooperative activities and annual reporting on the progress made. The reports were subsequently made public and forwarded to the Council of the Commission for Environmental Cooperation. The Parties also continued their commitment to the principle of prior informed consent (PIC): if an importing country does not consent to import a chemical substance, the exporting country has the obligation to inform the exporting industry of that decision and take appropriate legislative and administrative measures to ensure that export does not occur.

The NARAP for chlordane was intended to be the basis of a coordinated regional contribution to these international initiatives. A number of specific regulatory and administrative actions were included:

1. The United States encouraged industry to voluntarily phase out chlordane production;
2. Canada and the US worked closely with Mexico to provide available risk assessments concerning suitable alternatives to chlordane;
3. Canada and the US continued to provide support for hazardous waste collection programmes that included chlordane. Information on these programmes was shared with Mexico, which administered its own hazardous waste collection programme;
4. All three countries reported publicly available data on chlordane use, production, import and export;
5. Canada, Mexico and the US produced annual reports on progress achieved under the NARAP.

Implementation and benefits

After production ended in the United States, the next step was to find out how much chlordane was being used in Mexico and where. Canadian and US agencies came to Mexico in order to demonstrate the best and cheapest ways to test for chlordane and monitor its use. They shared detailed information on the elimination of its use and on which regulations had been effective. The CEC also set up workshops to explain the dangers of chlordane and present alternatives. For example, heating furniture above certain temperatures kills termites just as effectively as spraying with a noxious chemical.

Mexico imported 212.8 tonnes of chlordane between 1992 and 1996, all from the US.

Use of chlordane in Mexico is currently illegal. This means that the use, commercialization, import and formulation of chlordane and of its active ingredient are prohibited by law. Its phase-out is now complete, as the only company holding a chlordane active ingredient registration stopped importing it in 1997 and had no stocks by 1999. Apparently, no pesticides containing chlordane were imported at that time.

Another factor in the success of this programme is that it encouraged optimism about similar low-cost efforts in the future. Apart from a few grants to Mexico for some studies, the bulk of the work consisted of exchanging expertise and techniques, with information dissemination and capacity-building actions.

What also made this easier was the fact that Mexico had begun to control the use of chlordane. By 1997 this was limited to urban use to control termites, mainly in houses. However, completely ending chlordane's use took several more years and required mutual help across the continent.

ferred easily to developing countries is not yet certain. Resistance to pests in the US may not confer resistance to indigenous pests in developing countries. The other dimension is that pests have been shown to develop resistance to Bt crops if their use is not managed properly.

Improvements in yield and stress tolerance

Much of the benefit of the first Green Revolution came about through the development of high-yielding dwarf varieties. The genes responsible for dwarfing have now been isolated and can be incorporated into other crops to achieve the same increased yields. In many regions of the world there are constraints on where crops can be grown since these regions have highly alkaline, acidic or saline soils. Genes conferring resistance have been isolated from plants such as mangroves and are being inserted into crop varieties to enable them to be grown in saline soils. This has the potential to reclaim large areas of land that have been made saline by poor irrigation practices.

Improvements in nutrition

GM technology not only has the ability to produce plants that address many production problems. It also has the potential to improve nutritional quality. One widely known example is the so-called "Golden Rice", which has been engineered to produce higher levels of beta-carotene as a precursor to vitamin A, which could help treat deficiencies in children living in the tropics.

There can be little doubt that GM technology has the potential to meet the world's food demands, but a number of questions still remain partially or totally unanswered. Many people are concerned about the potential for the spread of modified genes into the environment, either creating "super weeds" or polluting the genetic material of wild plants. Herbicide-tolerant plants can generally be controlled with conventional herbicides other than the one to which they are resistant. Whether the modified material will make its way into the native flora is less certain. The limited number of species that have been modified, and their relatively limited distribution, have not really produced sufficient information to make a decision. There is a need to monitor the situation very carefully, especially where plants are being used in their centre of origin and gene flow may be easier. Human safety is also of concern since genetic modifications could lead to allergies or worse. However, over half a million hectares of GM crops have

The main elements of the integrated pest management (IPM) strategy developed as part of the regional cooperation plan were:
1. biological control (use of species of bacteria such as *Bacillus thuringiensis*; use of fungi, including *Metarhizium anisopliae* and *Beauveria bassiana*);
2. physical barriers such as sand traps for underground termite control;
3. baits such as food or substances used to attract, entice or lure termites to a desired location. The baiting technique involves the use of a "bait station" on which the termites aggregate and continue to feed once they have found the bait station.

The safer chemical alternatives identified were chlorpirifos (Dursban), deltamethrin, permethrin (Dragnet), cypermethrin, and fipronil (Termidor).

In developing and implementing this programme there were a few challenges along the way, including:
1. lack of a detailed inventory of quantities used at the start of the Regional Action Plan;
2. difficulty in finding the resources to gather monitoring and follow-up data;
3. lack of enforcement instruments to measure success.

Mexico also took several steps with wider implications on its own initiative, showing that the government was becoming more environmentally conscious. One of the first steps was to ban the import of chemicals that were prohibited in the producing country. Mexico thereby recognized the need to stop companies from turning to export markets when their products were deemed dangerous at home.

Studies were also carried out for the first time on chlordane use in Mexico and its effects on birds, fish and worms. Contamination in these animals, although they are lower down on the food chain, quickly makes its way to humans.

The NARAP included a three-phase regulatory programme specific to Mexico, which has resulted in the effective implementation of actions within the regional plan. This programme has also had positive benefits through reducing exposure to chlordane. Among the actions taken have been:
1. development of an integrated control strategy including a pesticide life-cycle analysis, identification of alternatives to chlordane and government support for research;
2. encouragement of stakeholders to participate in the development of control strategies and the identification of safer alternatives;
3. a ban on imports of pesticides whose use is prohibited by the exporting country;
4. limits on sales to authorized, trained personnel and restrictions regarding their use;
5. making information on the NARAP's scope and purpose available to the public;
6. prohibition of the sale of technical and active ingredients for making chlordane;
7. environmental monitoring and risk assessment to establish a baseline.

Conclusions

The North American Regional Action Plan on Chlordane can be considered a successful tri-national cooperation exercise, designed to curtail release to the environment of a toxic, persistent and bioaccumulative substance at the regional level. As a result of these NARAP activities, chlordane is no longer registered for use or manufactured in Canada, Mexico or the United States. Mexico's institutional capacities for monitoring and analyzing chemicals in the environment have been strengthened in terms of information systems for toxic substances and actions to reduce the risks of toxic substances. The design and implementation of a chlordane sampling and analysis plan for Mexico is included under the Regional Action Plan on Monitoring and Assessment, currently under development.

This experience has demonstrated the great benefits of regional cooperation when priority is given to the management and control of substances of mutual concern that are persistent and toxic. The authorities are now confident enough to say publicly that Mexico has eliminated chlordane use completely. To ensure that chlordane levels continue to decrease over time, follow-up recommendations have been made to report on chlordane levels and activities by means of continued monitoring and surveillance of illegal trade.

Current field studies at selected sites in Mexico are being coordinated by the National Institute of Ecology. These studies are geared towards measuring a number of POPs (including chlordane) as part of the follow-up recommendations.

Furthermore, and in compliance with international initiatives such as the Basel and Stockholm Conventions, Mexico has had the opportunity to take advantage of this regional cooperation and share the experience and expertise gained.

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1. See www.chem.unep.ch/pops.

been grown and consumed without any apparent ill effect.

Among the key elements of the use of GM technology are how it is developed and used and by whom. It is essential that the poor in the developing world have access to this technology if appropriate. Currently a huge majority of the technology is owned by a relatively few multinational companies. The only way to use it is to pay for the seed or licence. Patent laws give complete control to the companies if they register a modified gene in a plant, irrespective of the fact that many of the traits that already exist were developed by others. Historically, there has been an exchange of plant material for breeding programmes between countries. This has enabled the rapid development of new varieties suited to particular countries. This will not be the case with the modified crops as it currently stands.

There has already been a case in Canada where a farmer was found to have a patented crop growing on his land and was prosecuted by the seed company for infringing the patent rights, although he claims he did not plant the modified seed on his land. Thus a principal has been established that somebody who has suffered from "genetic pollution" is liable for damages. The patent law, originally developed for non-living things, does not deal well with living ones and now appears to put a lot of power into the hands of the multinationals.

The future

There are a number of approaches to meeting the need for more food in the years ahead. More land can be brought into production, certainly, but only by clearing more natural habitat. Agriculture can become more intensive with ever higher inputs, but this is clearly not sustainable in the long term in terms of energy inputs or the problems of pollution from excess fertilizer and pesticides. There are real opportunities to reduce the impact of agriculture by adopting integrated pest and crop management where increased understanding of the ecology of crop production is used to better manage pests and diseases through rotations, crop resistance, biological control and better managed pesticide use. Organic production will have a part to play in satisfying a small proportion of the developed world market, but also as a suitable production system for many subsistence farmers.

The use of GM technology appears to offer significant opportunities to increase production without damaging the environment. It may actually offer the possibility of reducing the impact of food production. Whether these benefits are realized will depend on how the technology is used. If developing countries are given access to GM technology at a sensible price (which could be zero) and the necessary skills and information can be delivered to farmers so that they can exploit the technologies, then there is a real chance of being able to meet the needs of the 842 million hungry people and the 2 billion extra ones in the next 30 years.

Conclusion

Whichever of these routes is followed (and there are strong arguments for going down the integrated management route where pesticide use is reduced but yield is largely maintained), there is a clear need to be able to develop solutions that are appropriate to the circumstances of individuals and the situations in which they farm. Good arguments have been put forward pointing out that some manifestations of IPM are totally inappropriate to developing country agriculture, having been developed in the Northern countries (Morse and Buhler 1997). The same can perhaps be argued for GM technology. Use of agrochemicals is already starting to decline in some countries through policy changes, and possibly also the adoption of GM technology, while it continues to increase in others. This pattern is likely to continue for some time. However, the long-term aim must be a reduction in the overall use of pesticides to improve the sustainability of agriculture worldwide.

It would be nice to be able to do without any pesticides at all, but realistically there will be a need for responsible, targeted use in the foreseeable future to obtain the level of production required. The key to implementing these changes is to get information and knowledge to the farmers that will enable them to implement the different solutions that are already available and, at the same time, to increase our understanding of the complex interactions that occur in all agro-ecosystems in order to develop new solutions.

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Effects of an environmental tax on pesticides in Mexico

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Summary
An optimal pesticide tax would discriminate among the substances marketed according to their toxicity levels. Adopting such a tax in Mexico is the most efficient way to prepare for compliance with the future extension of the list of pesticides subject to phase-outs and elimination under international agreements. This article examines the implications of three different environmental tax options: a general 15% tax on all pesticides (compensating for their current exemption from the value added tax); a differential tax of 15, 10, 5 or 0% based on toxicity levels; and a 10% tax focused on the most toxic substances currently authorized. Tax revenues should be used to pay for restoring human and ecosystem health as well as to compensate for other types of damage as appropriate.

Résumé
Pour être optimale, toute taxe sur les pesticides doit faire une distinction entre les substances commercialisées en fonction de leur degré de toxicité. L'adoption d'une taxe de ce type au Mexique est le moyen le plus efficace de préparer le pays à l'allongement futur de la liste des pesticides qui risquent d'être progressivement abandonnés et éliminés en vertu d'accords internationaux. L'article étudie les implications de trois options différentes d'écotaxe : une taxe générale de 15 % sur tous les pesticides (compensant leur exemption actuelle de TVA) ; une taxe différentielle de 15, 10, 5 ou 0 % en fonction du degré de toxicité ; et une taxe de 10 % qui toucherait les produits les plus toxiques actuellement autorisés. Les recettes fiscales correspondantes seraient utilisées pour améliorer l'état de santé de la population et des écosystèmes, ainsi que pour compenser tout autre type de préjudice si nécessaire.

Resumen
El impuesto ideal sobre pesticidas discriminaría las sustancias comercializadas en función de sus niveles de toxicidad. La adopción de este impuesto en México representa la manera más eficaz de preparar al país para cumplir con la próxima extensión de la lista de pesticidas sujetos a procesos de eliminación gradual y total en el marco de los acuerdos internacionales. Este artículo analiza las implicaciones de tres impuestos ambientales distintos: un impuesto general de 15% sobre todos los pesticidas (para corregir el hecho de que actualmente están exentos de IVA); un impuesto diferencial de 15, 10 ó 0% con base en su nivel de toxicidad; un impuesto de 10% sobre las sustancias más tóxicas autorizadas. Los ingresos derivados de dichos impuestos deberán destinarse al pago de los costos que implica la restauración de la salud humana y del ecosistema, y a cubrir otros tipos de indemnizaciones.

Pesticides are generally a good investment for farmers. It was estimated by Carrasco-Tauber (1990) that farmers obtained US$3-6 in crop damage reduction for every dollar spent on pesticides in the United States. Similar outcomes must be the case worldwide, as every year agricultural producers purchase close to 2.5 million tonnes of 55,000 different pesticides (Pimentel, et al. 1992). Most of the demand stems from the real profitability of the technology. However, farm support policies contribute to an increase in the demand for pesticides, in some cases to the extent that their marginal benefits are less than the private cost of production.

With or without subsidies, from an environmental point of view we face a problem with pesticides. Generalized use of herbicides, insecticides and fungicides has increased risks and resulted in direct or indirect damage to human health, wildlife and ecosystems. The number of cases of intoxication by pesticides reported to the Mexican Health Ministry has increased steadily over the last decade. Water pollution, damage to ecosystems or fisheries, and other types of environmental damage receive less attention or systematic analysis, even if anecdotal evidence suggests that this issue is not irrelevant.

Environmental costs are not paid by pesticide producers or by users. This implies that some current use of pesticides is beyond the point at which society as a whole actually benefits from their use.

Mexico is an active participant in the major international agreements concerning pesticides. It has signed the Stockholm and Rotterdam Conventions, although it is still in the process of ratifying the Stockholm Convention. Full compliance with the Conventions' current requirements is not considered a problem. But we believe that current agricultural policy in Mexico is an obstacle to any phase-out policy for new pesticides to be listed under the Stockholm Convention.

Mexican policy on pesticides has been to prohibit the most dangerous compounds,[1] while only requiring the provision of information for the rest. Despite prohibiting the 12 worst widely known pesticides, Mexico is not as advanced as other industrialized countries: pesticides banned elsewhere (e.g. paraquat, endosulfan, lindane, methyl bromide, parathion and malathion) are still authorized for use.

The problem with the authorization/prohibition policy tool is that it is too blunt. It does not allow dealing with targets that involve gradual shifts or phase-outs for pesticides that are authorized but still of concern. Moreover, there is a serious problem with policy coordination in Mexico. While agricultural policy seeks to increase production by providing subsidies for water, energy and agrochemicals, the Environmental and Resource Ministry has to address the ensuing problems of depleted aquifers and pesticide pollution. The situation with respect to pesticides is one of clearly distorting support measures: there is an exemption from the value added tax (which is 15% on all goods except medicine and food) and a system of matching grants under which selected participants pay nearly 30% less than the market price.

The case for an environmental tax

Decoupling environmentally harmful subsidies and fiscal exemptions for pesticides requires substituting direct support policies for them. Providing grants in cash instead of reducing prices would allow economic signals of the cost (private and social) of pesticides to guide farmers' decisions; at the same time real incomes would not be reduced.

Even better, an environmental tax on pesticides (based on toxicity levels) would change the relative prices of the most problematic pesticides. This would induce a change towards the more environment-friendly products and practices, and towards a more efficient application of the more environmentally harmful options.

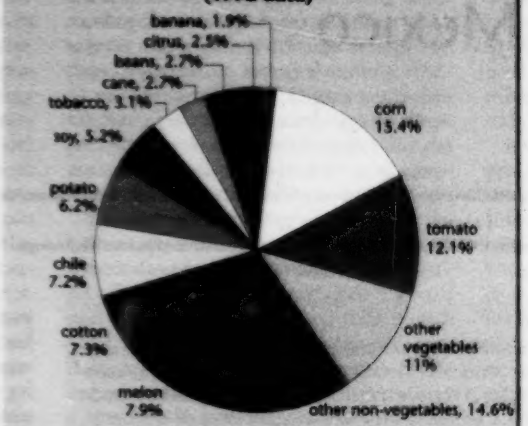
In the last two decades economic instruments

have been widely acknowledged to be a useful but under-utilized tool for achieving environmental goals. At the same time, environmental policy has been straining to prevent environmental damage instead of repairing it. The real connection between these two ideas has not yet been made. Mexico relies heavily on command and control policies. It is argued by environmentalists (supporting government officials and industry lobbies) that these policies provide greater certainty of environmental outcomes and are less expensive for complying firms. Nevertheless, we strongly believe that the flexibility and efficiency of economic instruments in middle-income countries like Mexico should not be underestimated. In the case of pesticides, this means acting in the grey area where the case for prohibiting substances is not strong but doing nothing is not desirable either.

Among Organisation for Economic Cooperation and Development (OECD) countries, Denmark, Sweden, France and Norway have successfully introduced a levy on pesticides where there is some degree of differentiation according to toxicity. Arie Oskam (1997) summarizes (using three basic points) the main lessons from the international experience concerning how to design a successful levy on pesticides:

1. Levies should be set according to the health or environmental damage pesticides cause. The most hazardous substances should be subject to the highest tax rate. If possible, taxes should be set with reference to the economic value of the marginal externality (social) cost.
2. The levy should have adequate means of collection and be fraud-proof. The main effect of substitution will be lost if more toxic substances are taxed less.
3. Reimbursing revenues from the levy to farmers in a neutral way increases the measure's political acceptability, but this must be done using a mechanism with low transaction costs.

Figure 1
Pesticide market according to main crops treated (1992 data)



Source: Asociación Mexicana de la Industria de Plaguicidas y Fertilizantes, November 1993

Table 1
Types of pesticides and scenarios for environmental taxes

WHO classification of pesticides	Share of sales in Mexico 2003 (%)	Environmental tax (%)		
		Option 1	Option 2	Option 3
WHO Ia-Ib (highest toxicity)	17	15	15	10
WHO II (high toxicity)	44	15	10	0
WHO III (medium toxicity)	21	15	5	0
WHO IV (low toxicity)	18	15	0	0
Total	100			

Source: Survey on local sales of pesticides, Instituto Nacional de Ecología, 2003

Scenarios for Mexico

If environmental taxes are to be differentiated according to potential damage, we need an objective and robust way to classify pesticides according to their toxicity. For the creation of scenarios we chose as our classification system the one used by the World Health Organization (WHO). This system looks mainly at human health. Although the ranking would hold for most mammalian species, it is not necessarily correlated with other indicators of interest such as aquifer pollution or damage to birds, fish and beneficial insects.[2] The advantage of this system is that it is widely known and has a strong appeal to a broad constituency. Of course, the main disadvantage of using a single indicator is that it considers only one dimension of the problem at hand, whereas some pesticides that are relatively benign in one respect could be relatively hazardous in another.

The amount of the tax is another issue. There are as yet no studies that monetize the value of environmental damage caused by pesticides in Mexico. Total internalization of this cost through the tax cannot be achieved. Thus, we follow a simpler rule. Given that pesticides are exempt from the 15% VAT, we set the highest tax level at 15% and the lowest at 0%, allowing for the largest possible variation. **Table 1** summarizes the three options analyzed. The first option is the equivalent of eliminating the VAT exemption. The main drawback of this option is that it does not discriminate among substances that are less or more harmful. Although it strongly reduces pesticide use, there is very little change in the shares of the types of pesticides used. The second option is a gradual reduction of the tax, leaving only the best pesticides (from an environmental point of view) exempt. With the third option, the worst pesticides are taxed at 10%, leaving the rest exempt.

The tax would be applicable to all manufacturers or importers of the basic pesticides. If mixes were prepared (to be placed on the market as different products), the environmental tax would not be applied twice.

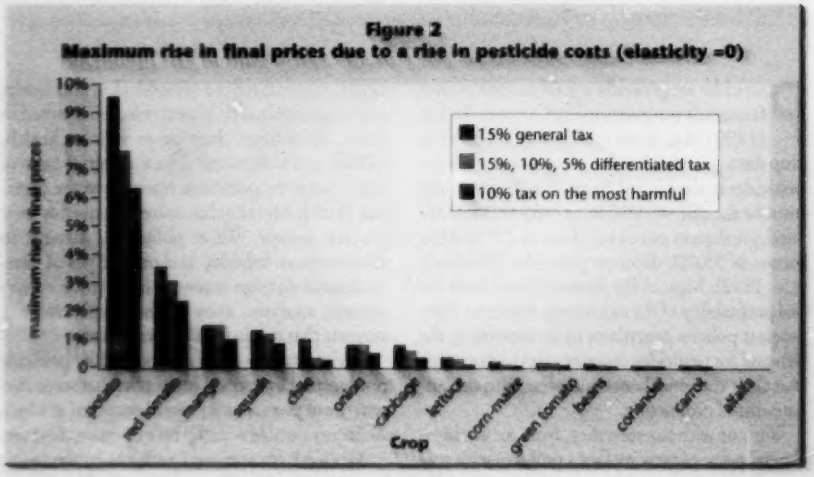
Costs to producers and consumers

Introducing an environmental tax on pesticides in Mexico would increase the costs to agricultural producers. Depending on elasticity of supply and demand, producers would pass on some of the increase to consumers. This section considers one of the extremes (i.e. when all costs are passed on to consumers) and estimates price increases for each tax option. The next section will demonstrate how different elasticities of demand would actually change patterns of pesticide use (one of the policy's stated objectives).

Table 2 shows production costs and net income for key crops in Mexico, selected because for their volume, such as corn (maize) and beans, or because of their importance as exports (e.g. tomatoes). Expenditure on pesticides varies widely (also see **Figure 1**).

Table 3 provides an upper bound for the price increases that would follow imposition of the environmental tax, where all cost increases due to the tax are passed on from growers to their buyers (also see **Figure 2**). As expected, the greatest price increases are for pesticide-intensive crops like potatoes and tomatoes. With the option of a full VAT on all pesticides, the price of potatoes would increase by nearly 10%. However, the effect on

Figure 2
Maximum rise in final prices due to a rise in pesticide costs (elasticity =0)



the prices of corn and beans, two of the basic foods consumed by lower income groups in Mexico, is less than half a percentage point.

The market for pesticides in Mexico is characterized by perfect competition. There are 163 registered firms. The nine largest accounted for 76% of total sales in 1999. The remainder are firms that import pesticides and combine them in different formulae for retail sale. It is important to note that the strategic behaviour of the large core firms could actually change these results.

Table 2
Average input cost and profits (selected crops)

Crop	Production costs per hectare (US$ per year*)	Costs of pesticides per hectare (US$ per year*)	Net income per hectare (US$ per year*)	Costs of pesticides (% of total costs)	Costs of pesticides (% of net income)
Green tomato	2266	52	6820	2.3	0.8
Potato	2535	995	4681	39.3	21.3
Chile	684	47	3808	6.8	1.2
Onion	1177	66	3268	5.6	2.0
Carrot	436	4	3110	0.8	0.1
Mango	3039	295	2932	9.7	10.1
Cabbage	653	35	2178	5.3	1.6
Lettuce	514	15	2062	2.9	0.7
Squash	1300	112	2024	8.6	5.5
Red tomato	3476	685	1604	19.7	42.7
Coriander	351	4	1194	1.0	0.3
Alfalfa	782	0	299	0.0	0.0
Beans	420	5	227	1.2	2.2
Corn (maize)	454	11	147	2.4	7.3

*All data provided are for the 2002-2003 season (spring-summer or perennial)

Source: National Survey of Pesticide Use in Agriculture 2003, Instituto Nacional de Ecología

The tax-changing patterns of consumption

The previous discussion assumed that the tax would just be passed on to the consumer, and that agricultural producers' decisions would not be modified at all. But the purpose of the environmental tax is not only to make polluters pay for damage caused, but also to induce changes in behaviour by forcing producers and consumers to assume the real costs.

The key concepts for determining how behaviour would be modified are the own-price elasticity and cross-price elasticity of demand. The former is the ratio of the percentage change in the quantity of a pesticide that consumers wish to acquire to the percentage change in the pesticide's price. Cross-price elasticity is similar, except that the change in price is that of competing pesticides.

The literature on demand for pesticides shows that in general the demand is inelastic. A 1% increase in price brings about less than a 1% decrease in the quantity demanded. **Table 4** summarizes some of the empirical findings. The highest price elasticity recorded is -0.7 in the long term for herbicides in the United Kingdom. Most studies indicate a range of -0.2 to -0.5.

We have created three scenarios using elasticities that cover the ranges reported in the literature. The first has an elasticity of zero (no change), as in the case used to estimate the maximum price increase. The second has an elasticity of -0.7, near the high end of the spectrum of empirical studies. The third has an elasticity of -0.35, the middle point between the previous two.

Table 5 shows the revenues one would expect to be collected under each elasticity scenario, with two tax options: tax rates falling with toxicity, only the most toxic of the authorized pesticides being taxed at 10%.

Since the objective of an environmental tax is not to increase revenues *per se* but to stimulate behavioural change, the taxes collected can be used to minimize the impact on producers' profits. Likewise, the fact that those funds are due to the internalization of negative externalities with respect to the health of neighbours and ecosystems would support the argument that they must be used to compensate for damage, pay for restoration or invest in other health-enhancing policies. The public policy suggestion would be to allocate these new resources so as to maximize political support for this measure.

Cross-price elasticities

The issue of cross-price elasticities is a difficult one. From the point of view of economic theory, the price of close substitutes (such as two types of pesticides) would certainly influence the demand for each of them. However, we could find no empirical study that actually estimated this. Thus, to create a realistic scenario we assume cross-price elasticity between categories of pesticides is 1 (i.e. a 1% increase in the price of a pesticide would increase demand for those in a different toxicological category by 1%.) The closer the substances are in terms of their effect on pests, the higher this number would actually be. In a sense, assuming an elasticity of 1 provides us with a lower bound for the expected results.

The scenario under which we would observe more significant changes in the demand for pesticides is that of setting the environmental tax according to toxicity (15-10-5-0%), where own-price elasticity is high (-0.7) and there is a cross-price elasticity of 1.0. **Table 6** shows how the market share would shift from the status quo to this last scenario. It can be observed that it does indeed create a gradual shift away from the more toxic pesticides towards more environmentally friendly options. This is not as drastic a change as would be induced by a prohibition, but it would be a strong move to prepare producers for an eventual ban, and probably a combination closer to the social optimum where all the external costs of pesticides are internalized.

Table 3
Maximum price increases for selected crops following imposition of an environmental tax

Crop	% increase in farm gate prices		
	Option 1: 15% tax on all pesticides	Option 2: 15-10-5-0%	Option 3: 10% tax on group with highest toxicity
Potato	9.7	7.8	6.5
Red tomato	3.7	3.2	2.5
Mango	1.6	1.6	1.1
Squash	1.4	1.2	1.0
Chile	1.1	0.4	0.4
Onion	0.9	0.8	0.6
Cabbage	0.8	0.7	0.5
Lettuce	0.5	0.4	0.2
Corn (maize)	0.4	0.2	0.2
Green tomato	0.2	0.2	0.2
Coriander	0.2	0.1	0.1
Beans	0.2	0.1	0.1
Carrot	0.1	0.0	0.0
Alfalfa	0.0	0.0	0.0

Conclusions

The most important conclusions to be drawn are:

1. When policies are developed to reduce the use of harmful substances, standards set in international agreements have an important influence on decision-makers in terms of the tools to be used and the criteria for applying them.
2. The most efficient way to comply with international agreements, and to eliminate from the market several substances whose use is dangerous, is to create economic incentives so that these substances gradually disappear. If the price of the most harmful pesticides increases, the market will gradually shift to less damaging practices at the minimum possible cost.
3. The literature considers a low elasticity of pesticide demand. This means that it is more likely that the chemical industry will not lose revenues; instead, the farmer or the final consumer will absorb the impact of a price increase. It also means that revenues would be relatively high, as farming practices will not change (at least in the short term). These revenues need to be used to compensate for damages, pay for restoration or invest in other health-enhancing policies.
4. When the most important agricultural

Table 4
Estimates of own-price elasticities of pesticide demand

Study	Country	Estimated elasticity	% change in demand as response to 15% price increase	Remarks
Oskam (1992)	Netherlands	-0.1 (mixed farms) -0.5 (specialized farms)	1.5-7.5	Medium-term
Oskam (1997)	European Union	-0.2 to -0.5	3-7.5	Review of several studies
DHV and LUW (1991)	Netherlands	-0.2 (arable farms) -0.3 (horticulture)	3.5-4.5	Short-term
Oude Lansink and Peerlings (1995)	Netherlands	-0.5 -0.7 (with CAP reform)	7.5-10.5	1970-92
Russell (1995)	UK	-1.1	16.5	For cereal only; 1989-93
Falconer (1997)	UK	-0.3	4.5	Using linear programming model
ECOTEC (1997)	UK	-0.5 to -0.7	7.5-10.5	Herbicides; long-term; cereal crops
Dubgaard (1987)	Denmark	-0.3	4.5	Using threshold model
Dubgaard (1991)	Denmark	-0.7 to -0.8	10.5-12	Long-term; 1971-85
Rude (1992)	Denmark	-0.2 to -0.3	3-4.5	Only herbicides
Schulze (1983)	Germany	-0.5	7.5	Only fungicides
Johnsson (1991)	Sweden	-0.3 (insecticides) -0.4 (fungicides)	4.5-6	Based on field experiments
Gren (1994)	Sweden	-0.4 (fungicides) -0.5 (insecticides) 0.9 (herbicides)	6-13.5	Econometric model
SEPA (1997)	Sweden	-0.2 to -0.4	3-6	Review of studies
Rude	Norway	-0.2 to -0.3	3-4.5	
Carpentier (1994)	France	-0.3	4.5	Arable farms
Papanagiotou (1995)	Greece	-0.28	4.2	

Source: Hoevenagel, et al. (1999)

Table 5
Estimated revenues generated by an environmental tax on pesticides (US$ million)

Own price elasticity	Tax option 1 15-10-5-0%	Tax option 2 10-0-0-0%
0	132.7	25.0
-0.35	127.9	23.7
-0.70	123.1	22.4

Table 6
Estimated revenues generated by an environmental tax on pesticides

WHO classification of pesticides	Share of sales in Mexico	
	Status quo 2003(%)	Tax option 1 (%) 15-10-5-0%
WHO Ia-Ib (highest toxicity)	17	11
WHO II (high toxicity)	44	30
WHO III (medium toxicity)	21	28
WHO IV (low toxicity)	18	30
TOTAL	100	100

crops marketed in Mexico are considered, the most radical scenario is a 15% VAT on all pesticides. In this case, the highest impact is a 9.7% rise in the price of potatoes, followed by tomatoes with a 3.7% rise in the worst case. This article considers the case in which the agrochemical industry and the farmer pass the impact on to the final consumer by increasing the price of final goods.

5. If a differential tax were imposed, the tax on potatoes would increase by 7.8% while the price of other crops would increase by less than half a percentage point. This scenario allows the farmer to shift to less harmful pesticides; the impact on farmers' revenues appears not to be significant. The third scenario considers a 10% tax on the most harmful pesticides. Tomatoes would be subject to a 6.5% increase in the final price, potatoes to 2.5% and the rest of crops a 1.1% or less increase.

6. Although large quantities of pesticide are used on crops such as corn (maize), the impact on individual farmers does not appear to be important. In the case of corn, the highest impact is a 0.4% rise in the final price. The other basic food consumed by lower-income groups in Mexico, beans, would be subject to less than half a percentage if there were a 15% tax on all pesticides.

7. The design of the instrument is meant to be complemented by the introduction of additional measures to enhance environmental effectiveness. These additional measures could include education, investment in alternative technologies, research and best practice management.

8. It is recommended that revenues be used to finance the additional measures mentioned, and to achieve acceptability at the political and social level.

Notes

1. There are some exceptions in the prohibitions. For example, only the Health Ministry can use DDT and then only in the case of an outbreak of malaria.

2. The report *Design of a Tax or Charge Scheme for Pesticides* (see References) make a comparison between various pesticide rankings according to toxicity to different elements of biodiversity. It shows a positive, but not perfect correlation.

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The Africa Stockpiles Programme: cleaning up obsolete pesticides; contributing to a healthier future

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An innovative, on-the-ground initiative is nearing operational launch in Africa, following nearly four years of preparations. The Africa Stockpiles Programme (ASP) is a multi-stakeholder partnership involving African countries, international agencies, non-governmental organizations, the private sector through CropLife International (CLI), and regional bodies. ASP's goal is ambitious: to clean up and dispose of existing pesticide stockpiles throughout Africa within the next ten to 15 years, and to help prevent future accumulations, at a total cost of US$ 250-300 million. Thanks to Global Environment Facility (GEF) foundational support of $25 million, and co-financing from donor governments, over $50 million has been raised for the first phase of activities in 15 countries. Close to another $20 million, however, is still required for phase 1 work and phase 2 planning.

What is the problem?

Stockpiles of obsolete pesticides have been identified throughout the African continent, many in rotting, rusting containers or bags that were stored or discarded up to 40 years ago. Some of the stockpiles contain extremely toxic pesticides including persistent organic pollutants (POPs), which are banned internationally by the Stockholm POPs Convention. As these chemicals spill and leach from their containers, they threaten rural and urban populations and contribute to land, air and water degradation. Contamination of soil, air and water affects some of the poorest, most ill-fated communities across the continent. Many governments are aware of the dangers but lack sufficient funding and technical capacity to address this ever-worsening problem.

Even in industrialized countries the regulation and management of pesticides is often inadequate. But in developing countries the lack of adequate resources for education, control and enforcement have translated into a far more precarious situation. In Africa alone, the buildup of obsolete pesticides has reached over 50,000 tonnes and has contaminated tens of thousands of tonnes of soil.

What caused it?

The factors behind this accumulation include:

- poor import controls;
- inappropriate procurement and central purchasing policies;
- untimely distribution;
- inadequate stock management;
- aggressive sales practices;
- pressure to stockpile for unforeseen emergencies;
- lack of coordination between donor agencies;
- receipt of products that are outdated or mislabelled (or labelled in the wrong language).

Despite the committed efforts of the Food and Agriculture Organization (FAO) and others over the last decade to address the pesticide stockpiles problem, these obsolete chemicals continue to accumulate more quickly than they are being removed. The clean-up of old pesticide stocks has rarely been perceived as a priority development issue, despite their health and environmental consequences and their disproportionate impact on the poor.

Pesticide barrels (PAN-UK)

How does the ASP solve the problem?

At the national level, the ASP will contribute to national development and country assistance strategies in the areas of public health improvement, poverty alleviation, environmental protection and the strengthening of the agricultural sector. At the global level, ASP will contribute to international efforts to eliminate POPs, improve the management of toxic chemicals and promote integrated pest management. Clean-up and disposal activities will be a direct implementation of the Stockholm POPs Convention and the associated GEF operational programme aiming to reduce the impacts of POPs on the global food chain, transboundary waters, soil and biodiversity. The ASP will also contribute to the objectives of other international agreements such as the Rotterdam, Basel, Biological Diversity and Bamako Conventions, as well as the Montreal Protocol.[1]

How did the ASP come about?

The idea of an Africa-wide stockpile clean-up project started to take shape during informal discussions at the final negotiating session of the Stockholm POPs Convention in Johannesburg, South Africa, in December 2000. The initial participants included WWF, the Pesticide Action Network (PAN)-UK, CropLife International (CLI), the World Bank, the Food and Agriculture Organization of the United Nations (FAO), UNEP, the Secretariat for the Basel Convention, and the UN Industrial Development Organization (UNIDO). Expanded participation in subsequent planning has included the African Union, the Economic Commission for Africa, the New Partnership for African Development (NEPAD), PAN-Africa, the UN Institute for Training and Research (UNITAR) and the World Health Organization (WHO).

How will the ASP be executed?

The clean-up, disposal and prevention work will be done in conjunction with existing efforts related to the prevention and disposal of obsolete pesticides. Such an ambitious plan of action would only be possible with the active engagement of multiple partner organizations. NEPAD, for example, has identified the ASP as one of its highest priority initiatives, uniting Africans in finding common solutions to shared problems. At another level, CropLife International is participating as both donor and technical advisor, having committed several million dollars for disposal operations (in phase 1) and in in-kind contributions of technical assistance to countries for inventory, safeguarding, transport and destruction aspects of the programme.

ASP implementation and institutional arrangements draw heavily on cooperation among the partners, their *continued on page 38*

☞ continued from page 37

comparative advantages, and historical involvement in developing the programme. Three entities will provide overall guidance for programme implementation:

- The *ASP Conference*, which will meet annually, is open to all ASP stakeholders. It will work by consensus in providing recommendations on overall direction;
- The *ASP Steering Committee*, comprising a 10 to15-member subset of the partners, will more regularly review and guide ASP progress;
- *Project Management Units* will be the principal implementers of the individual country programmes, hosted by the government agencies serving as the country-specific implementing agencies and guided by the national steering committees.

Institutionally, three global components have been created to provide coordination, oversight and technical support:

- The *Project Coordination Unit*, initially hosted by the World Bank and later to be transferred to an African regional development agency, will serve as the secretariat for the entire ASP. It will play a key role in organizing meetings, fundraising, monitoring and evaluation. This unit will also help ensure that contributions from individual countries and global components are focused on country needs and are in line with best technical and fiduciary approaches, as agreed by the partners.
- The *Technical Support Unit*, hosted by FAO, will coordinate delivery of technical services to countries for preparation, design, implementation, supervision and monitoring of country level activities. These will include, for example, technical guidelines for clean-up operations, assistance in managing procurement and supervision of specialized contractors, health and safety procedures, and assessment of laboratory capacities. FAO will play a lead oversight role in the transport of wastes from Africa and their disposal in EU-regulated European incinerators. CLI will manage complementary activities, focused primarily on technical assistance for safeguarding and disposal of wastes.
- The *Cross Cutting Activities Management Entity* will tackle issues that cross borders or that concern multiple countries, such as selecting appropriate stockpile disposal or safeguarding technologies; hosting the online information management system; coordinating communications activities in tandem with the World Bank; overseeing NGO/civil society awareness raising and capacity-building; and facilitating ASP relations with relevant international agreements such as the Stockholm POPs Convention.

Which countries will participate?

All the African countries that have ratified the Stockholm Convention will be eligible to take part in the ASP. Countries participating in the first phase of clean-up and prevention activities are Ethiopia, Mali, Morocco, South Africa, Tanzania and Tunisia. Nigeria will carry out prevention work and preparations for disposal. Inventory estimates indicate that there are about 10,000 tonnes of obsolete pesticides at more than 1400 sites in these countries.

Further preparatory operations and prevention activities are slated to begin in 2005-06 in additional countries to be selected based on their ratification of the Stockholm Convention, geographic distribution, pesticide stockpiles problems, commitment to ASP objectives and other factors. Preparations for clean-up work include a range of activities involving the training of personnel, detailed inventory of obsolete pesticide stocks, environmental risk assessment of pesticide storage sites, technical and financial planning, and emergency safeguarding (repackaging and securing) of any pesticide stocks that pose especially high risk to health or environment. Candidate countries for this follow-on phase include Benin, Botswana, Cameroon, Côte d'Ivoire, Egypt, Ghana, Lesotho, Mozambique, Rwanda and Senegal. Inventory estimates indicate that there are more than 4000 tonnes of obsolete pesticides at hundreds of sites in these countries.

Pesticide spraying of banana trees

How will ASP ensure that this problem doesn't reoccur?

Prevention activities and clean-up and disposal activities are considered by ASP partners to be of equal importance. To help prevent future accumulations of obsolete pesticides, ASP will engage in a range of activities including:

- *strengthening pesticide management* through improvement of pesticide registration, licensing, enforcement of import controls, stock management, waste management and formulation of effective procurement strategies;
- *promotion of alternatives* to chemical pesticides through improvement of pest control strategies, with particular attention to integrated pest management in agriculture and integrated vector management for public health. Prevention activities will also include the awareness and training of pesticide distributors, users and others to encourage safe pesticide handling and alternative pest control.

Who is funding the ASP?

The ASP has secured more than US$51 million to date to carry out clean-up and prevention operations in phase 1 countries. Twenty-five million dollars is coming from the new POPs focal area of the GEF. Additional funding comes from donor governments including Belgium, Canada, Denmark, Finland, France, Japan and Switzerland, as well as from the European Union and the World Bank's Development Grant Facility. CLI and other partners are also providing direct funding and/or in-kind contributions.

The Africa Stockpiles Programme brings together the skills, expertise and resources of a diverse group of stakeholders, enabling national leadership to carry out country-led activities. This exciting, path-breaking initiative offers real solutions to a difficult problem. By reducing and removing longstanding toxic threats throughout Africa, the ASP promotes improved public health, poverty reduction and environmental safety – critical elements of sustainable development.

1. Stockholm Convention on Persistent Organic Pollutants (2001); the Rotterdam Convention on the Prior Informed Consent Procedures for Certain Hazardous Chemicals and Pesticides in International Trade (1998); the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1989); the Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Wastes within Africa (1991); the Montreal Protocol on Substances that Deplete the Ozone Layer (1987); the Convention on Biological Diversity (1992).

The evolution of Canada's approach to minimizing environmental and health risks from mercury

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Summary

Human health concerns underlie Canada's approach to limiting releases of anthropogenic mercury. Mercury is a naturally occurring element that is ubiquitous in the environment. Routes of exposure are complex. While the scientific literature and policies and regulations refer to mercury levels in the environment, it is methylmercury (a neurotoxin) that is referred to. Methylation of particulate and reactive mercury into organic methylmercury produces toxic effects. The Canadian government has promulgated a range of policies and regulations to minimize health and environmental risks from this and other toxic chemicals. It also works with Canada's provincial and territorial governments and is active in bilateral, regional and international activities.

Résumé

Des préoccupations concernant la santé des hommes sous-tendent l'approche adoptée par le Canada pour limiter les rejets de mercure anthropiques. Le mercure est un élément naturel omniprésent dans l'environnement. Les voies d'exposition sont complexes. Bien que la documentation scientifique, les politiques et les réglementations parlent de niveaux de mercure dans l'environnement, c'est au méthylmercure (une neurotoxine) qu'elles font référence. La méthylation du mercure particulaire et du mercure réactif produit le méthylmercure organique, fortement toxique. Le gouvernement canadien a adopté une série de politiques et de réglementations pour réduire les risques que présentent ce produit chimique et plusieurs autres pour la santé publique et l'environnement. Il travaille également avec les autorités provinciales et territoriales du pays et participe activement à des activités bilatérales, régionales et internationales.

Resumen

El enfoque canadiense para limitar la liberación de mercurio antropogénico es resultado de una preocupación por la salud humana. El mercurio es un elemento natural ubicuo en el medio ambiente y las vías de exposición humana al mercurio son complejas. Aunque la literatura científica, las políticas y la normatividad hacen referencia a los niveles de mercurio en el ambiente, en realidad se refieren al metilmercurio (una neurotoxina). El proceso de metilado de partículas de mercurio y de mercurio reactivo para producir metilmercurio orgánico tiene efectos tóxicos. El gobierno canadiense ha promulgado una serie de políticas públicas y normativas a fin de minimizar los riesgos ambientales y para la salud que entrañan éste y otros productos químicos tóxicos. Asimismo, colabora con los gobiernos provinciales y territoriales del país, y participa en actividades bilaterales, regionales e internacionales.

Mercury is found in air, water, soil and biota (the flora and fauna of a region). It exists in many forms in the environment. These forms have different properties that affect distribution, uptake in the food chain (i.e. bioavailability) and toxicity.

Mercury is a naturally occurring element, persistent by definition. It is unique among metals, in that it is liquid at ambient temperature. Named after the Roman god of commerce, travel and thievery, it has been used for more than 3000 years. Also known as "quicksilver", it was known to the ancient Chinese and Hindus before 2000 BC. Mercury has been found in tubes in Egyptian tombs dating from about 1500 BC. It was first mentioned by Aristotle in the fourth century BC, when the heavy, silvery-white metal was used to form amalgams with other metals for ointments and cosmetics. Elemental mercury is readily transformed into mercury vapour. The vapour can be transported by air and is readily taken up by air-breathing organisms.

Reactive mercury (referring to the ionic form) can easily be converted into methylmercury, an organic compound that is highly toxic. Methylmercury is bioavailable, bioaccumulates, and biomagnifies as it moves up the food chain from fish to mammals, including humans.

Particulate mercury consists of compounds that are bound in soil, sediment and aerosol particles. These compounds are not generally easily bioavailable, but they can be released as a result of human activity. For example, flooding of large areas of land for hydroelectric generating stations generally transforms particulate mercury into methylmercury, potentially contaminating fish and fish-eating mammals in the area.

Redistribution of mercury as a result of human activity or industrial processes (anthropogenic sources) has increased since the industrial era. It could now be responsible for a significant percentage of total emissions to the atmosphere each year. The main sources of mercury emissions today are coal-fired electric power plants, waste incinerators, chlor-alkali facilities still using the mercury cell process,[1] primary copper and lead smelters, and cement manufacturing. Mercury is still used in batteries, but this use has been declining as manufacturers switch to alternative metals. Other shrinking markets include electrical applications (ranging from metallic mercury switches in thermostats to mercury-vapour discharge lamps), dental amalgams, temperature- and pressure-measuring devices, detonators, pigments and pharmaceuticals. While increased concerns related to the health and environmental risks of mercury exposure have led to greater restrictions on its uses, its unique properties will likely guarantee its use in some key sectors (e.g. energy-efficient fluorescent lamps) in the foreseeable future.

Environmental and health issues, monitoring and assessment

Methylmercury is a known neurotoxin that slows fœtal and child development. It causes irreversible deficits in brain function. Scientific debate to more precisely determine the level at which effects begin to occur is ongoing, although recent epidemiological studies on Arctic populations have shown that even low levels of methylmercury have some effect (even if much more subtle), affecting fine motor function, visual spatial abilities and verbal memory.[2]

It is important to point out that while the scientific literature, policies and regulations refer to "mercury" levels in the environment, it is methylmercury that is referred to and it is the methylation of particulate and reactive mercury into organic methylmercury that produces toxic effects.

Effects on biota and the establishment of mercury concentration trends in the environment are

important elements in developing an appreciation of the risk posed to the Canadian environment by mercury and its organic compounds.[3] Environmental monitoring is common in areas where methylation is known to occur, such as partially acidified watersheds, watersheds with large wetlands high in dissolved organic carbon, and reservoirs. Loons,[4] seabirds, Arctic marine mammals and fish are frequently surveyed. Data reveal that different fish species generally contain different levels of mercury, with predators like lake trout, walleye and northern pike containing higher levels than forage feeders like cisco and whitefish. The reasons why there are different levels in different species are not yet clear and are the subject of ongoing investigation. Other factors being constant, mercury contamination of fish in smaller lakes tends to be higher than that of those in larger lakes. One possible reason is that smaller lakes tend to be warmer, a factor that increases methylation of mercury.

Canada has established and maintains national and regional databases that identify elevated levels of metals, including mercury in various media (air, water, soil, biota). In addition, there are numerous provincial initiatives including databases for mercury levels in fish.[5]

Monitoring occurs in freshwater bodies and in sediments. It has become evident from sediment core profiles that strong regional mercury accumulation gradients exist.

However, the presence of inorganic mercury in sediments needs to be correlated with levels of methylmercury in the food chain, as the mere presence of mercury does not explain *how* it enters the food chain.

One recently discovered mechanism, seemingly unique to the Arctic, relates to the polar sunrise each spring. Since 1995 researchers have monitored a drop in the concentration of gaseous elemental mercury over the period from the first sunrise in the spring until snowmelt. It seems that elemental mercury becomes oxidized to reactive mercury, which is then deposited on the snow; snowmelt is the main source of freshwater for most Arctic landscapes. More research is needed to determine *if* and *how* this reactive mercury becomes bioavailable to terrestrial and aquatic ecosystems.

In the Arctic, where consumption of fish and traditional game food such as seals, toothed whales, caribou and moose is high, mercury exposure in some communities[6] exceeds the Health Canada and World Health Organization (WHO) tolerable daily intake level.[7] In these communities there is growing awareness of the potential risks to health from a diet of mercury-contaminated game food.

Human health considerations are a key factor underlying Canada's initiatives aimed at limiting the release of mercury to the environment. However, given that mercury is ubiquitous in the natural environment, the routes of exposure to humans are complex. They can include mercury vapour (from inorganic mercury compounds) and organic methylmercury.

Programmes, policies and guidelines for risk management of mercury

Canada has federal legislation, regulations and guidelines relevant to the control or reduction of mercury

- in air;
- in fresh and drinking water;
- in waste effluent;
- during marine disposal;
- at contaminated sites;
- during transportation as product or waste;
- in consumer products;
- in pest control products;
- during occupational exposure.

In addition (and as Canada is a federation made up of ten provinces, each with its own constitutional authority), federal regulations are supplemented by provincial acts, regulations and guidelines covering liquid effluent, drinking water and emissions from industrial sources.

The Canadian government has established a process involving Health Canada, Indian and Northern Affairs Canada (INAC), the Canadian Food Inspection Agency (CFIA), Fisheries and Oceans Canada and Environment Canada (EC) implementing statutes, regulations and departmental mandates to protect the health and environment of Canadians. Specifically, Health Canada establishes standards for the amount of mercury humans may consume without adverse health effects. Environment Canada's mandate includes the preservation and enhancement of the quality of the natural environment, including water, air and soil quality. INAC ensures that northern communities[8] are aware of the health hazards of consuming traditional foods that may contain higher levels of mercury. CFIA deals with the commercial inspections of fish products before they are sold on the Canadian market. Fisheries and Oceans maintain inland fisheries.

Provincial governments have the responsibility to perform monitoring and testing programmes which include sampling fish from a variety of lakes and rivers, analyzing fish samples for contaminants, issuing fish consumption advisories, if needed, and informing the public of these advisories. It is also the responsibility of provincial governments to issue fish advisories (recommendations against eating fish from specific lakes), although recreational anglers can continue to catch fish under a "catch and release" philosophy.

The Canadian, provincial and territorial governments and Aboriginal peoples work in partnership to monitor exposure of adults and children, particularly those who consume the greatest quantities of fish, marine mammals and game food (that is, those animals that feed on fish). While the majority of this work is centred in the Canadian North, it also includes southern communities with a higher than average consumption of country foods. While monitoring in the past relied on blood mercury levels, researchers now prefer hair analysis as a more accurate method of monitoring continuous exposure.[9] Since the neurotoxic effects of methylmercury are most likely irreversible, it is important to know the peak exposure of an individual.

Canada's regulatory approach to minimizing mercury's environmental and health risks

To minimize the environmental and health risks from toxic substances, the federal government has promulgated a range of policies and regulations, which are described below.

Minerals and metals policy of the government of Canada

Canada's policy on the sustainable development of minerals and metals,[10] adopted in 1996, is based on

- life-cycle management;
- risk assessment and risk management;
- safe use;
- science and technology;
- recycling.

Life-cycle management is an essential part of environmental stewardship. It provides the overarching framework for realizing the policy's other aspects and is closely linked to risk assessment and the principle of safe use. In managing minerals- and metals-related health and environmental issues, the principle of life-cycle management, for both processes and products, plays an essential role.

Inherent in the life-cycle management of metals, including that of mercury, is the application of risk assessment and risk management processes. Risk assessment estimates the degree and likelihood of adverse effects resulting from exposure to a substance from a process or product. Risk management is the process of deciding what to do about an assessed risk, taking into account the results of the risk assessment and economic, social and legal factors.

The Safe Use Principle guides the development of regulatory or non-regulatory strategies to manage the risk, based on the results of the risk assessment for a particular product during production, use, re-use, recycling or its ultimate return to the environment. By adhering to the Safe Use Principle, governments will ensure that society continues to benefit from minerals- and metals-related products, such as energy-saving fluorescent lights, while protecting human health and the environment in a manner consistent with sustainable development.

Canada's minerals and metals policy recognizes the important role of science and technology in the achievement of sustainable development. At the present time, the Canada Centre for Mineral and Energy Technology (CANMET) is the lead laboratory for the OECD's validation study of a transformation dissolution protocol (T/DP), data from which will be used in the United Nations Globally Harmonized System of Classification and Labelling (GHS) for the hazard identification and classification of metals and sparingly solid metal compounds with respect to the aquatic environment.[11] The T/DP may also be extended to alloys. In addition, the T/DP and the GHS could be applied to mercury and its compounds.

Recycling is a key component of sustainable development, offering environmental as well as economic benefits. To achieve recycling's full

potential, however, existing domestic and international regulations including the Basel Convention need to remove impediments that may unduly restrict the movement of legitimate materials, particularly in instances where movement controls may not be commensurate with the risks posed by the individual recyclable material. It is also important to differentiate clearly between recyclable materials destined for legitimate recovery operations and wastes destined for disposal, so as to apply appropriate risk management controls in each case.

Canadian Environmental Protection Act, 1999

The Canadian Environmental Protection Act, 1999 (CEPA) provides the Minister of the Environment with authority to make regulations with respect to mercury and other substances listed as toxic. The *Chlor-Alkali Mercury Release Regulations* under CEPA limit the release of mercury into ambient air from mercury chlor-alkali plants. Provisions are included with respect to reporting releases, malfunctions and breakdowns.[12] At the same time, there are chlor-alkali mercury liquid effluent release regulations under the *Fisheries Act*.[13]

The *Export of Substances Under the Rotterdam Convention Regulations*,[14] also under CEPA 1999, controls the Prior Informed written Consent of materials moved under the Rotterdam Convention. Most of the substances in Annex 1 are organo-mercury pesticides.

The *New Substances Notification Regulations of CEPA, 1999* require that mercury compounds not on Canada's list of in-use substances (the Domestic Substances List) be deemed new to Canada. Any introduction requires notification and assessment under these Regulations.

Toxic Substances Management Policy

The Canadian federal *Toxic Substances Management Policy* provides a framework for making scientifically valid decisions with respect to effective management of toxic substances. Track 1 substances are targeted for virtual elimination from the environment if they are persistent and bioaccumulative toxics emitted predominantly from human activity. Naturally occurring substances such as mercury are not candidates for Track 1 virtual elimination, as that would be impossible. Track 2 substances are toxic substances or substances of concern that need to be managed throughout their life cycle to prevent or minimize their release to the environment. A Track 2 substance in the environment may be targeted for virtual elimination from the environment if it poses unacceptable risks to the environment or human health. The Policy establishes precautionary, proactive and accountable rules for dealing with toxic substances.

Other relevant federal legislation

The *Northern Contaminants Programme*[15] works towards reducing and, where possible, eliminating contaminants including heavy metals such as mercury, persistent organic pollutants (POPS) and radionuclides in traditionally harvested country food, while providing information that assists individuals and communities in making informed decisions about food use.

Mercury transported in any form is regulated by the *Transport of Dangerous Goods* Regulations, under the Transport of Dangerous Goods Act, as a corrosive/toxic substance.[16] The transport of radioactive mercury is regulated under the *Federal Atomic Energy Control Act*, administered by the Atomic Energy Control Board of Canada. Under regulations to the *Canada Shipping Act*, the discharge of mercury or mercury compounds to any Canadian territorial water is prohibited.[17]

Under Canada's *Hazardous Products Act* it is prohibited to sell, advertise or import into Canada toys, equipment or any other product that contains mercury for use by a child.

At one time mercury-containing pesticides were regulated under the *Pest Control Products Act*, but these uses ended in 1998.

Occupational exposure limits for mercury are equivalent to the values published by the American Conference of Government and Industrial Hygienists in Threshold Limit Value and Biological Exposure Indices under the *Canada Labour Code*. The *Workplace Hazardous Materials Information System* regulations prescribe standards for the use, storage and handling of controlled products (including mercury and its compounds) in the workplace.

Under the rubric of the Canadian Council of Ministers of the Environment (CCME), federal, provincial and territorial governments work cooperatively on interjurisdictional issues such as air pollution and toxic chemicals to establish nationally consistent standards, strategies and objectives for achieving a high level of environmental quality across Canada. Since 1998 CCME has developed Canada-wide standards (CWS) for several significant mercury-emitting sectors and for selected products containing mercury. These include standards for mercury emissions from base metal smelters, waste incineration and mercury-containing lamps, and for dental amalgam waste. A CWS for mercury emissions from coal-fired electric power generation is under development.[18] CWS for control actions for persistent compounds such as mercury can only reduce anthropogenic emissions to approach background levels; these are developed based on the "precautionary approach".

Intergovernmental initiatives

Minerals and metals and their impact on human health and the environment have been considered in a number of venues since the 1992 Rio Earth Summit, through to the 2002 Johannesburg Summit. Canada has been and remains an active participant in intergovernmental initiatives, such as the UN Economic Commission for Europe (UN-ECE) Heavy Metals Protocol to the Convention on Long-Range Transboundary Air Pollution. The objective of the Heavy Metals Protocol is to control emissions of heavy metals (cadmium, lead, mercury) that are subject to long-range transboundary atmospheric transport and are likely to have significant adverse effects on human health or the environment. The Protocol entered into force in December 2003. Other initiatives in which Canada is an active participant include the OECD Risk Reduction Programme, the Intergovernmental Forum on Chemical Safety, the Arctic Council and UNEP's Global Mercury initiative.[19]

Regionally, Canada is a party to NAFTA and its Commission for Environmental Cooperation, along with the United States and Mexico. Under a framework agreement on the Sound Management of Chemicals (SMOC),[20] a SMOC Working Group on Mercury developed North American Regional Action Plans (NARAPs) including one on mercury. As NARAPs are intended to be results-oriented, guidance documents are also developed to establish ground rules for implementing the NARAPs. The 1997 NARAP on Mercury recommended holding Workshops on Partnerships/Voluntary Initiatives and on the State of Scientific Knowledge Related to Mercury. These were held in 1998. The Task Force on Mercury reconstituted itself as an Implementation Committee to assist in specific actions to further reduce anthropogenic releases of mercury generated within North America. Their efforts are ongoing.

Bilaterally, Canada is a member of the Canada-US International Joint Commission, which takes an ecosystem approach to ensuring healthy waters within the Great Lakes-St. Lawrence basin and other watersheds along the borders of the two countries. Mercury is specifically targeted in the Great Lakes Binational Toxics Strategy (1997).

Voluntary mercury reduction initiatives

The Accelerated Reduction/Elimination of Toxics Initiative (ARET)[21] grew out of a proposal in late 1991 from a group of leading industry executives and environmentalists, known as the New Directions Group, to the federal Minister of the Environment. They proposed a cooperative approach to identify, then reduce or eliminate the most significant toxic substances. The Minister created the ARET Stakeholders Committee in 1992. Its first task was to evaluate and prioritize some 2000 substances, based on an inventory of substances found in the Great Lakes Basin. Substances were scored on the basis of available toxicity, persistence and bioaccumulation data. The result was a list of 117 toxic substances slated for reduction or elimination. Methylmercury was listed as A-1, meaning virtual elimination of its emissions to the environment from human activities (with a short-term goal of 90% reduction by 2000). Elemental and inorganic mercury were classified under list B2, meaning a reduction of anthropogenic emissions to levels that are insufficient to cause harm, with the short-term goal a 50% reduction by 2000.

In 1994, the Stakeholder Committee issued the ARET Challenge to Canadian industry to voluntarily reduce or eliminate releases of ARET substances by the year 2000.

Results as of 2003 show that of the 303 facilities

participating in ARET, including 13 mining companies, 118 have already met or exceeded their 2000 ARET reduction targets in all the substance categories they report on. While the reduction of persistent, bioaccumulative and toxic substances on the A1 level is somewhat slower than expected (at 52% reduction from the base year), ARET participants continue to make good progress towards achieving their targets. Releases of elemental and inorganic mercury have been reduced by 88.7%.

While not every company in Canada participated in this initiative, ARET has demonstrated what is technically and economically possible.

Challenges, knowledge gaps and areas of uncertainty

Because mercury is a naturally occurring element, *distinguishing natural from anthropogenic* sources is difficult. There are complexities in relating atmospheric levels to levels observed in fish and other biota. As a result of these complexities, it is currently uncertain to what extent reductions in the anthropogenic component of mercury in the atmosphere may correspond to measurable reductions in ecosystems, including those in remote areas such as the Arctic.

Information is needed to assess mercury inputs from active volcanic regions of North America, including both passive degassing and eruption events. Researchers at the University of Hawaii[22] have indicated that volcanic mercury emissions tend to be underestimated in global inventories, and Canadian researchers[23] have noted that contributions of mercury to the oceans from submarine volcanism and other sea floor processes have been neglected in published global budgets.

Conclusion

Canadian governments have taken proactive initiatives to reduce anthropogenic emissions of toxic substances, including mercury, to the environment. Regulations and policies have been complemented by voluntary industry initiatives and supported by scientists who continue to investigate how naturally occurring elements like mercury enter the food chain, so that these routes can be mitigated.

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Notes

1. This was the primary use of mercury in Canada until the 1960s.
2. *State of the Arctic Environment Report*, 2002 (www.amap.no), pp. 86-89.
3. Canada's Submission to UNEP's Global Mercury Assessment, September 2001.
4. The blood mercury levels of common loons increase from west to east across Canada and the US. They are generally highest in southeastern Canada, with the highest value (.6 ppm) from birds nesting in Kejimkujik National Park.
5. For reference, see www.ec.gc.ca/MERCURY/EN/efca.cfm.
6. *State of the Arctic Environment Report*, 2002 (www.amap.no).
7. Canada's Submission to UNEP's Global Mercury Assessment, op. cit.
8. Northern communities are those north of 60 degrees north latitude.
9. Health Canada uses a factor of 300 to convert hair mercury levels to blood levels; the WHO uses a factor of 250.
10. *The Minerals and Metals Policy of the Government of Canada: Partnerships for Sustainable Development*, 1996 (ISBN 0-662-251540-7) (www.nrcan.gc.ca/mms/sdev/policy-e.htm).
11. See www.unece.org/trans/danger/publi/ghs/ghs.html.
12. See www.ec.gc.ca/CEPARegistry/regulations.
13. Mercury in daily effluent must not exceed 0.00250 kg/tonne of chlorine times the reference production rate.
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Cleaner production in the Indian dye and dye intermediate industry: a successful preventive environmental management strategy for waste minimization and resource conservation

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Summary

Chemical manufacturing is one of India's oldest domestic industries. This article focuses on the dye and dye intermediate sector. Many companies in the sector are SMEs. In the last decade or so they have experienced severe financial pressures at the same time as growing demands to improve their environmental performance. End-of-pipe treatment of waste and emissions has been promoted, but with only limited success as it is cost-intensive (and changing the form of the waste is not the same thing as eliminating it). Most of the limited number of cleaner production initiatives undertaken in India thus far have been demonstration projects. By implementing cleaner production measures, participating companies have improved productivity, cutting costs and reducing their pollution loads. The savings realized are potentially many times the original investment.

Résumé

La fabrication de produits chimiques est l'une des industries domestiques les plus anciennes de l'Inde. L'article s'intéresse plus particulièrement au secteur des teintures et des auxiliaires de teinture. Beaucoup d'entreprises de ce secteur sont des PME. Depuis une dizaine d'années, elles sont confrontées en même temps à de fortes pressions financières et à des exigences de plus en plus nombreuses d'amélioration de leurs performances en matière d'environnement. Le traitement des déchets et des émissions en fin de cycle de fabrication a été encouragé mais avec un succès limité car il est coûteux (et changer la forme du déchet, ce n'est pas l'éliminer). La plupart des initiatives de production plus propres (encore peu nombreuses) menées en Inde jusqu'à présent sont des projets pilotes. Grâce à des mesures de production plus propre, les entreprises participantes ont pu améliorer leur productivité tout en réduisant leurs coûts et les volumes de polluants produits. Les économies réalisées peuvent être plusieurs fois supérieures à l'investissement de départ.

Resumen

La producción de químicos constituye una de las industrias nacionales más antiguas de la India. Este artículo trata el sector del teñido y teñido intermedio de textiles, en el que muchas de las empresas son pymes. En los últimos diez años, más o menos, han enfrentado fuertes presiones financieras al mismo tiempo que crecientes exigencias para mejorar su desempeño ambiental. Se ha promovido el tratamiento de desechos y emisiones con controles al final del proceso (end-of-pipe), aunque se ha tenido poco éxito debido a lo intensivo de los costos (sin olvidar que cambiar la forma del desecho no equivale eliminarlo). Hasta ahora, la mayoría de las contadas iniciativas de producción más limpia realizadas en la India ha consistido en proyectos de demostración. Al aplicar medidas de producción más limpia, las empresas participantes han mejorado su productividad mediante la reducción de costos y de cargas de contaminación. Es muy probable que el ahorro logrado alcance una cifra muy superior a la inversión.

The development of the first synthetic dyestuff by William Henry Perkins in 1856 led to the birth of the European dyestuff industry. Use of synthetic dyes expanded to all textile substrates, and soon they began to be used in India's already well-developed textile industry. However, in India the industry depended on imported organic dyestuffs until the 1940s and the start-up of the first Indian company, Arlabs Ltd.[1] In the 1950s and 1960s a number of other companies were established with foreign collaboration.[2] By the 1960s the stage was set for rapid growth in this industry.

Today the Indian dyestuff and dye intermediate industry (DDI) comprises about 950 units (organized sector, 50; unorganized sector, 900) with an overall capacity of about 1,500,000 tonnes per year. While most such plants in the world are large, in India the industry has successfully established small-scale plants capable of producing standard quality dyestuffs. The two western states of Maharashtra and Gujarat account for over 90% of national dyestuff production. At a time when standards for quality and reliability are rising, the Indian industry is meeting over 95% of domestic requirement.

Environmental challenges

The dye and dye intermediate industry (in which a wide range of chemicals are used) is one of India's most polluting industrial sectors. It has the potential to generate:

- liquid effluent containing non-biodegradable substances, acid/alkali/toxic trace metals/aromatic amines, and a large volume of dissolved solids and colour;
- hazardous solid waste, including iron sludge, gypsum, and sludge from effluent treatment plant containing organic and inorganic impurities;
- gaseous streams, mostly in the form of fugitive emissions.

Considerable environmental problems are also related to:

- batch processes where the batch size is small;
- frequent switching from one product to another;
- manual handling of materials;
- poor process control and consequent high process losses;
- lack of proper environmental management practices, particularly in the case of small-scale operations.

Until recently, end-of-pipe (EOP) control was the waste management strategy adopted in this sector. EOP involves physico-chemical or biological treatment of waste and emissions before they are discharged.

Some specific characteristics of liquid, solid and gaseous waste generated in the dye and dye intermediate industry are described below.

Liquid waste

Wastewater quality and quantity vary considerably (e.g. wastewater per tonne of dye produced is very low compared with wastewater per tonne of dye intermediate produced). In the case of major dye intermediates, specific wastewater generation is about 15-20 m^3/tonne of product. The main sources of wastewater generation are:

- mother liquor or filtrate streams from filtration operations;
- wastewater streams from washing of filter cake to remove salt impurities or residual filtrate adhering to the cake;
- leakage and spillage;
- floor washing in the work area.

Typical characteristics of wastewater from this sector are shown in **Table 1**.

Effluent discharged from this sector is highly acidic. It contains toxic compounds, many of which are carcinogenic. They can be very hazardous to human health and the environment. This is due to the presence in the wastewater of benzene, naphthalene, and other nitro-aromatic based compounds used as raw material in the production of dye intermediates. Due to excessive acid and alkali use, the wastewater also contains high concentrations of inorganic salts, resulting in high concentrations of total dissolved solids (TDS). Because of the high level of TDS and toxic aromatic compounds, effluent treatment is very difficult and expensive.

Under the regulations prevailing in India, there is currently no industry-specific effluent standard for the dye industry. The general standard therefore applies. According to this standard, effluent discharged by an industrial unit must meet the parameters in **Table 2**.

Management of liquid waste

Before 1994, many small and medium-sized units in this sector did not treat their wastewater. It was discharged directly to nearby surface water. Large units and some medium-sized ones carried out primary treatment, but almost none of these units met pollution norms.

Following strict regulatory action, and intervention by the High Court and Supreme Court, industries began detailed wastewater treatment. Today all units carry out primary wastewater treatment; some also have secondary and tertiary treatment systems. Nevertheless, it is still impossible to meet the prescribed Pollution Control Board norms. The reasons for this are:

- Industrial units (especially if they are small-scale) do not have enough land area to construct a treatment plant with a capacity of about 50,000-100,000 litres/day. Most plants are underdesigned;
- Treatment costs are very high. Units that are small-scale economically cannot afford treatment;
- The wastewater is very difficult to treat;
- The expertise needed for proper treatment is not available locally;
- Frequent product changes (based on demand) and poor process control at the production plant change effluent characteristics over time, thus disturbing the treatment system.

End-of-pipe treatment

End-of-pipe (EOP) treatment is a control strategy to protect the environment from the impact of waste and emissions discharged from industries. The EOP treatment strategy incorporates treatment of the waste and emissions generated to bring them to a particular level (considering the assimilative capacity of the receiving bodies) before discharge. The EOP strategy has existed since the establishment of India's Pollution Control Boards and the introduction of the Air and Water Pollution Prevention and Control Acts.

To meet prescribed standards, waste must be treated either physico-chemically or biologically. However, this strategy did not yield results due to poor enforcement and the prohibitive costs of treating waste to bring it to the desired levels. EOP waste treatment simply converts the form of the waste (e.g. air emissions scrubbed and turned into wastewater which is then treated again before disposal, leaving behind sludge to be disposed of in scientifically designed secured landfills).

The Government and Industry Associations have decided to build common effluent treatment plants (CETPs) for primary-treated industrial wastewater. The government has also taken steps to fund the CETP projects,[3] as well as research aimed at reviving the use of natural dyes, extension of MODVAT[4] benefits to pollution control equipment and other activities. It has also initiated a ban on 190 textile dyes (in view of the German ban on azo dyes) and emphasis is being given to substitute dyes. Similarly to the CETP initiative, steps need to be taken in the DDI industry with respect to common acid recovery to recover resources and to reduce waste treatment and disposal costs.

Table 1
Typical characteristics of wastewater from dye and dye intermediate production

Parameter	Value
pH	< 1
Chemical oxygen demand (COD)	50,000-1,00,000 mg/litre
Total dissolved solids (TDS)	15,000-2,00,000 mg/litre
Ratio of biochemical oxygen demand (BOD)/ chemical oxygen demand (COD)	<0.2

Table 2
General standard for effluent discharges in India

Parameter	Discharge standard
pH	6.5-8.5
COD	250 mg/litre
BOD	30 mg/litre
TDS	2100 mg/litre
Total suspended solids (TSS)	100 mg/litre

Table 3
Solid waste generation factors

Product	Waste type	SWGF*
Dye intermediate	• Sludge from wastewater treatment	1.2-1.6
	• Iron sludge	1.0-2.5
	• Gypsum sludge	3-12
	• Tarry waste	0.03-0.05
Dyestuff	• Sludge from wastewater treatment	1.2-1.6

* Specific waste generation factor, expressed as tonnes of waste generated per tonne of product

Solid waste

Large volumes of solid waste are generated by the dye industry – by the process and by wastewater treatment. A great deal of gypsum sludge is produced by primary treatment of acidic wastewater, where lime is used in neutralization. The types of waste generated by this process are:

- gypsum sludge;
- iron sludge;
- residues from the filter press;
- tarry waste;
- waste dye powder;
- packaging material.

This solid waste contains toxic chemical compounds. To minimize serious environmental impacts, proper disposal or treatment is required. The specific waste generation factors for different types of solid waste generated in this sector are shown in **Table 3**.

Management of solid waste

Under the Hazardous Waste (Management and Handling) Rules, 1989/2000, hazardous waste must be disposed of in a secure landfill facility. According to the rules and guidelines, all types of waste generated by the dye and dye intermediate sector belong to hazardous waste categories. Therefore, this waste has to be managed in an environmentally friendly way. All waste except tarry waste, which is incinerable, is to be disposed in a landfill facility following physical treatment.

Regulatory bodies have taken strict action against many units generating large volumes of hazardous waste. Many such units in the state of Gujarat have been closed down. A large number of common secured landfill facilities are already functional. Few existing or abandoned dumpsites have been remediated by "containing" the wastes with a protective covering (geo/cement lining) along the top and sides to avoid percolation of water and subsequent environmental damage.

Gaseous emissions

The major gaseous emissions from the dye and dye intermediate industry are unrecovered gases generated by the process. They are fugitive in nature. Emissions from unit processes generally contain

gases such as chlorine, sulphur dioxide and trioxide, nitrogen oxides, and fumes of acid and organic solvents. Much of the time, these by-products of unit processes are recovered subject to the cost of recovery and their market potential. They are normally gases like SO_2, HCl (hydrochloric acid, or hydrogen chloride) and organic products. If they are not recovered, they cause air pollution. A 100% recovery rate is not possible; the unrecovered product is vented from the stack.

Particulate matter emissions from the drying and grinding operation are another source of pollution. Concentrations can be as high as 500-600 mg/litre. Flue gas from the boiler is also a source of air pollution in this sector. Very high particulate matter emissions of the dyestuff in powder form are a major source of air pollution from the dyestuff production plant.

An emission standard exists for most types of gases and particulate matter (e.g. 50 mg/litre in the case of particulate matter).

Management of gaseous emissions

To meet emission limits, gases and fumes emitted from the stack are generally scrubbed using packed bed type scrubbers. Most SMEs in this sector are unable to comply with the standards for source or fugitive emissions.

Cleaner production in the chemical industry (dye, dye intermediates and pharmaceuticals)

Significant environmental degradation has occurred in various parts of India due to rapid development/industrialization. Greater environmental awareness and activism in all quarters, accompanied by the economic liberalization promoted by the Indian government, have left Indian SMEs struggling for survival. In the past decade they have experienced a financial crunch at the same time as growing pressure to improve their environmental performance. End-of-pipe treatment of waste and emissions is being promoted, but with only limited success since it is cost-intensive. And changing the form of the waste is not the same thing as eliminating it. Over the decade only a few cleaner production initiatives have been undertaken, mostly as demonstration projects. A few of these are briefly described below.

A cleaner production demonstration project was carried out in 12 chemical plants in 2001-02 by the National Productivity Council, located at Vapi, Gujarat. Participants were from the dye, dye intermediates and pharmaceutical sectors. During the project 788 cleaner production measures were identified. By the end of 2002, 380 had been implemented.

Implementing these measures required an investment of Rs. 8.5 million. This investment is expected to yield Rs. 40 million per year through improved productivity and reduced environmental load. The measures implemented include:

- use of purer grade naphthalene and of iron powder having higher activity, leading to an annual net saving of Rs. 0.18 million in addition to a 50% reduction of organics in sludge;
- substitution of inorganic for organic acid in the final isolation of NMJ (a dye intermediate) following purification, leading to an annual net saving of Rs. 4.3 million and a 50% reduction of effluent organic load;
- modification of acetonyl sulphonyl chloride (ASC) cake washing (static material water seeping through, changed to continuous stirring of material while washing), leading to a reduction of water and caustic consumption and improved quality of ASC. This measure produced economic savings of Rs. 6.6 million per year for an investment of Rs. 10,000;
- increasing the height of the distillation column, leading to improved recovery of isopropyl alcohol at a bulk drug manufacturing unit. This measure produced an annual net saving of Rs. 0.8 million for an investment of Rs. 0.38 million.

Ishan Dye Chem Ltd. (copper phthalo cyanine dye intermediate manufacturer)

M/s Ishan Dye Chem Ltd. is a small-scale dye intermediate unit that manufactures copper phthalo cyanine (CPC), which is further processed to produce alpha and beta blue dyes. The unit produces 100 tonnes of CPC per month. A cleaner production process was introduced in order to reduce water consumption, recover solvent effectively and conserve energy. Major CP measures implemented are:

- installation of a rotary air lock in a raw material feeding hopper to reduce solvent losses in the work atmosphere. This measure resulted in annual net savings of Rs. 1.8 million for an investment of Rs. 0.1 million;
- increasing vacuum pressure from 400 to 700 mm Hg for improved recovery of trichlorobenzene (TCB) from the heated mass in the vannulator. This measure, which required an investment of Rs. 0.5 million, led to annual net savings of Rs. 1.3 million.

Metrochem Industries Ltd., Ahmedabad (H-acid dye intermediate manufacturer)

M/s. Metrochem Industries Ltd. is a dye intermediate manufacturing industry with a production capacity of about 60 tonnes of H-acid (an important dye intermediate produced from naphthalene) per month. During the CP project 27 cleaner production measures were identified, of which 12 were implemented. The unit invested Rs. 2.8 million in implementing the CP measures. Annual savings of Rs. 51.0 million were achieved, in addition to a 34% reduction in pollution load, 20% reduction in fuel consumption and 12% reduction in electricity consumption. The most significant CP measures implemented are:

- increasing batch size by 10% to 1100 kg of naphthalene, producing immediate savings of about Rs. 11.3 million per year;
- installing a pressure-reducing valve to lower steam pressure from 12 to 5 kg/cm^2 in the reduction vessel, resulting in savings of about Rs.0.8 million per year;
- stopping the mother liquor blower in order to control the flow of the liquor to the incinerator in the zero discharge, resulting in savings of about Rs. 30,600 per year;
- increasing the amino concentration to 45°Be by five-effect steam evaporator, resulting in the reduction of caustic consumption, of mother liquor generation, of the sulphuric acid requirement in isolation and of the cost of incineration, as well as better recovery of Glauber's salt. This option has led to savings of about Rs. 3.7 million per year. Reduction of steam consumption alone has produced savings of Rs. 1.9 million per year.

ADCI Dyechem Pvt. Ltd., Ahmedabad (reactive dyes manufacturer)

M/s. ADCI Dyechem Pvt. Ltd. is a dye manufacturer with a production capacity of about 2400 million MT/year of reactive dyes (40 different dyes). During the CP project 32 cleaner production measures were identified, of which 17 were implemented. The unit invested Rs. 1.0 million in implementing CP measures and achieved annual net savings of Rs. 2.25 million, in addition to a 56% reduction in pollution load and 65% reduction in water consumption. The most significant CP measures implemented are:

- using the first wash water from filter press cake washing for wet cake dissolution;
- modifying product cake washing from three times (1000 litres of water per batch) to a single 1500-litre wash;
- using the first wash water from spray dryer washing for wet scrubbing of the spray dries. After concentration, the scrubbing liquor is spray dried to recover the product.

Alps Chemicals Pvt. Ltd., Ahmedabad (acid dye manufacturer)

M/s. Alps Chemicals Pvt. Ltd. is a small-scale

UNEP's definition of cleaner production

Cleaner production is the continuous application of an integrated preventive environmental strategy to processes, products and services to increase overall efficiency, and to reduce risks to humans and the environment. Cleaner production can be applied to the processes used in any industry, to products themselves, and to various services provided to society.

For the production process, CP results from one or a combination of conserving raw materials, water and energy; eliminating toxic and dangerous raw materials; and reducing the quantity and toxicity of all emissions and wastes at source during the production process.

For products, CP aims to reduce the environmental, health and safety impacts of products over their entire life cycles, from raw materials extraction, through manufacturing and use, to the "ultimate" disposal of the product.

For services, CP implies incorporating environmental concerns into designing and delivering services.

industry that manufactures various complex acid dyes and non-benzene direct dyes. Production is about 800 tonnes/year. A number of cleaner production opportunities have been identified and implemented. Through the implementation of 12 CP measures, the company achieved savings of about Rs. 2.1 million per year for an investment of Rs. 0.34 million. These measures were mainly related to very simple actions requiring negligible investment. The most significant are:

- installing transparent fibre-reinforced plastic (FRP) sheets in the roof to make use of sunlight for day lighting, resulting in savings of about Rs. 21,000/year;
- installing highly efficient, energy-conserving mixers, leading to savings of about Rs.1.19 million per year;
- covering the junction of the ice-conveying pipe with a flexible flap to reduce spillage losses, resulting in savings of about Rs. 10,000 per year;
- relocation of the induced draft (ID) fan close to the outlet of the cyclonic demister in the spray dryer, leading to a reduction in the fan's horsepower requirement and in the operating cost. Savings are around Rs. 0.3 million per year;
- collecting laboratory samples in separate containers and recycling them in corresponding product batches, leading to tremendous savings in product and a reduction of waste treatment costs (savings of about Rs. 0.5 million/year);
- installing a new high-capacity blender (8T) with better technology, leading to reduced energy consumption and savings of about Rs. 72,000 per year.

Dintex Dyechem Ltd., Ahmedabad (vinyl sulphone dye intermediate manufacturer)

M/s. Dintex Dyechem Ltd. manufactures 150 tonnes per month of vinyl sulphone (para amino phenyl B-hydoxy ethyl sulphate ester). The project resulted in 36 CP measures, of which 23 were implemented, leading to improved recovery of HCl and by-product (sulphuric acid, Glauber's salt, sulphanilic acid) recovery and significant reduction of water consumption and hazardous waste generation. The main measures implemented are:

- modifications to the HCl gas (generated during sulphonation) scrubber. Modified two-packed bed scrubbers with an ID fan were installed. In the first, HCl is scrubbed with water, along with cooling, for recovery. The second acts as a polishing scrubber, in which scrubbing is carried out with dilute caustic soda. Implementation of this recovery option has yielded annual net savings of Rs. 0.57 million for an investment of Rs. 0.1 million;
- installing a multi-effect evaporator to concentrate the mother liquor stream and first-wash liquor stream, generated from the Neutsch filter, to recover the sulphuric and sulphanilic acid. This measure, which required an investment of Rs. 9.0 million, has yielded annual net savings of Rs. 8.6 million;
- installing a spray drier to recover Glauber's salt from the condensation of mother liquor and make waste amenable to biological treatment. This measure involved an investment of Rs. 3.5 million and has resulted in annual net savings of Rs. 3.6 million;
- installing a bag filter to replace multi-clones for improved product recovery. Condensation product after drying had been recovered using multi-clones. This measure has resulted in annual net savings of Rs. 3.4 million for an investment of Rs. 0.8 million.

Conclusion

As seen from these examples, the experience of India's National Cleaner Production Centre with the chemical industry demonstrates that cleaner production is a desirable preventive strategy for environmental management. It can reduce costs and pollution loads as well as leading to resource conservation. Adopting cleaner production techniques minimizes the generation of waste and emissions. Thus the volume of waste to be treated is reduced, leading to minimized costs for treating the waste (which ensures that the waste is treated). Further, in most demonstration studies the major work was carried out by the industry team, using a systematic methodology which is self-sustainable in these companies.

This approach has had considerable success in the dye and dye intermediates sector and can be applied to other branches of the chemical industry. Cleaner production does not necessarily ensure environmental compliance in itself. However, along with reduced costs for waste treatment and disposal, it makes compliance easier.

Cleaner production is not only a good preventive environmental management strategy for minimizing waste and conserving resources. A closer look at the various CP measures indicates that most are focused on good housekeeping, operational control and recycling/recovery. Keeping in mind the technological status of Indian industries and stiff international competition, the cleaner production approach (along with the adoption of cleaner technologies) is essential.

Wastewater treatment

Basically, three levels of wastewater treatment are carried out.

The first (or preliminary) treatment is "primary treatment". Primary treatment is physico-chemical treatment, such as screening of the wastewater to remove floating particles or addition of chemicals to adjust the pH and aid precipitation of suspended particulate matter in the water, followed by use of the primary settling tank to settle the precipitated matter. In the place of primary settling tanks, mechanically aided primary clarifiers are also used. Following primary treatment, the wastewater is still harmful. Further treatment is necessary, either in-house or at a common treatment facility along with other effluents.

The second level of treatment is "secondary treatment". It consists of biological treatment, either with air added (aerobic treatment process) or in the absence of air (anaerobic treatment process), depending on the wastewater's characteristics. This is followed by secondary settling/clarification of the precipitated suspended particulates. After secondary treatment, the wastewater can be discharged safely. The level of treatment depends on prevailing discharge standards, and on whether the wastewater will be discharged to land or to water bodies. If the wastewater is going to be recycled, it needs to be treated further in a tertiary treatment plant.

During "tertiary treatment" the wastewater is polished/purified using water purification processes such as storage in polishing ponds and ultra filtration/membrane filtration. The level/type of tertiary treatment depends on the purpose for which the wastewater is being recycled.

Notes

1. Arlabs Ltd. was followed by others such as ATUL, IDI and Amar Dye Chem.
2. For example, Atic Industries, Suhrid Geigy and Colour Chem.
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Implementation of Design for the Environment (DFE) in a Mexican chemical group

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Summary

This article sums up a Mexican company's experience with implementing the Design for the Environment (DfE) concept in the research and development areas of its chemical sector. DfE is a sustainable development strategy. It can be used to detect potential environmental risks and to develop new products and processes. Once a DfE handbook had been produced, implementation was carried out in several steps in a non-aggressive way. It was hoped that those concerned would adopt DfE out of conviction rather than because they had to. Consequently, there was a strong emphasis on education and identification of opportunities. In the project's final phase, two ongoing technological projects were chosen for study: one at the pilot stage and the other at the commercial stage.

Résumé

L'article présente le cas d'une entreprise mexicaine qui a mis en œuvre le principe de conception écologique (Design for the Environment ou DfE) dans les activités R&D de sa branche produits chimiques. Le DfE est une stratégie de développement durable. Il peut être utilisé pour détecter des risques potentiels pour l'environnement et pour développer de nouveaux produits et procédés. Une fois le manuel de DfE réalisé, la mise en œuvre a été conduite en douceur en plusieurs étapes. Le but était que les personnes concernées adoptent le DfE par conviction et non par contrainte. L'accent a donc été mis sur l'éducation et l'identification des possibilités d'application. Lors de l'étape finale, deux projets technologiques en cours ont été choisis comme sujet d'étude : un au stade de l'essai pilote, l'autre au stade commercial.

Resumen

Este artículo presenta una síntesis de la experiencia de una empresa mexicana con la aplicación del concepto "ecodiseño" en el área de investigación y desarrollo del sector químico. El ecodiseño es una estrategia de desarrollo sostenible que puede ser empleada para detectar riesgos ambientales potenciales y desarrollar productos y procesos nuevos. Tras la publicación de un manual sobre ecodiseño, su aplicación se llevó a cabo gradualmente; se esperaba que los interesados adoptaran el ecodiseño por convicción y no por obligación. Por ende, se enfatizó con firmeza la importancia de la concienciación y la identificación de oportunidades. Durante la etapa final del proyecto se seleccionaron dos proyectos tecnológicos en curso para su análisis: uno de ellos en la etapa piloto y el otro en la etapa comercial.

Interest in the manufacture of products that are friendly to the environment is growing. Traditionally, products have been designed to meet clients' specifications. Today design is aimed not only at satisfying functional specifications, but also at reducing the toxicity of products and processes by promoting recycling and generating less waste (without compromising quality). This concept is called "Design for the Environment" (DfE) (**Figure 1**). Various other terms (e.g. "green engineering design") are used to suggest the same idea.[1] Where DfE or similar initiatives have been implemented, environmental technologies have been part of competitive business strategies.

Chemical industry challenges

Worldwide, the chemical industry is involved in the manufacture of most of the products we see around us. Among the factors currently influencing the industry's development are globalization, increasingly tough environmental performance standards, greater demand for profitability and productivity from financial markets, higher client expectations, and changing labour force requirements.

In decision-making the industry takes account of environmental demands and the opportunities to satisfy these demands. Companies make great efforts to comply with regulations, identify eco-efficiency opportunities, implement relevant administrative systems, optimize resources in their supply chains, etc. (**Figure 2**). However, only companies with vision focus on untapped markets, process updating, technological innovation (including changes in environmentally related technologies) and development of sustainable development strategies.

To meet today's environmental challenges, the chemical industry must address:

- appropriate supply chain management;
- more efficient use of raw materials, reuse and recycling of materials, and energy generation and use;
- the balance between environmental and economic considerations;
- long-term investments in research and development;
- interrelationships and mutual collaboration among industry, universities and government with respect to research and development (balancing resources and investments);
- product specialization.

Innovation (obtaining new knowledge which, supported by research and development, leads to new technologies) is therefore essential.

Mexico's environmental priorities

Voluntary and non-voluntary environmental legislation and regulations require the country's entire population to take part in maintaining a healthy environment. The chemical industry has to ensure that its operating framework includes strategic planning aimed at improving Mexico's environment.

Some of Mexico's environmental priorities are:

- soil protection;
- air quality;
- ocean pollution;
- afforestation;
- biosafety;
- water supply and treatment;
- emissions inventories;
- biodiversity;
- sustainability of fisheries.

In applying the DfE concept, DESC keeps these priorities in view.

Environmental innovation in the chemical sector of Grupo DESC

DESC SA de CV is one of Mexico's major consortiums. Its operations are focused on four sectors: chemicals, automotive, food and real estate. Chemical sector operations involve eight businesses and 13 manufacturing plants. Products include plastics, resins, laminated products, rubber and carbon black.

The company's Divisional Department for Environmental Control (DESC) promoted the Design for the Environment concept within the company to support the development of new products and processes in the chemical sector. As a sustainable development strategy, DfE was initiated by DESC with the following goals:

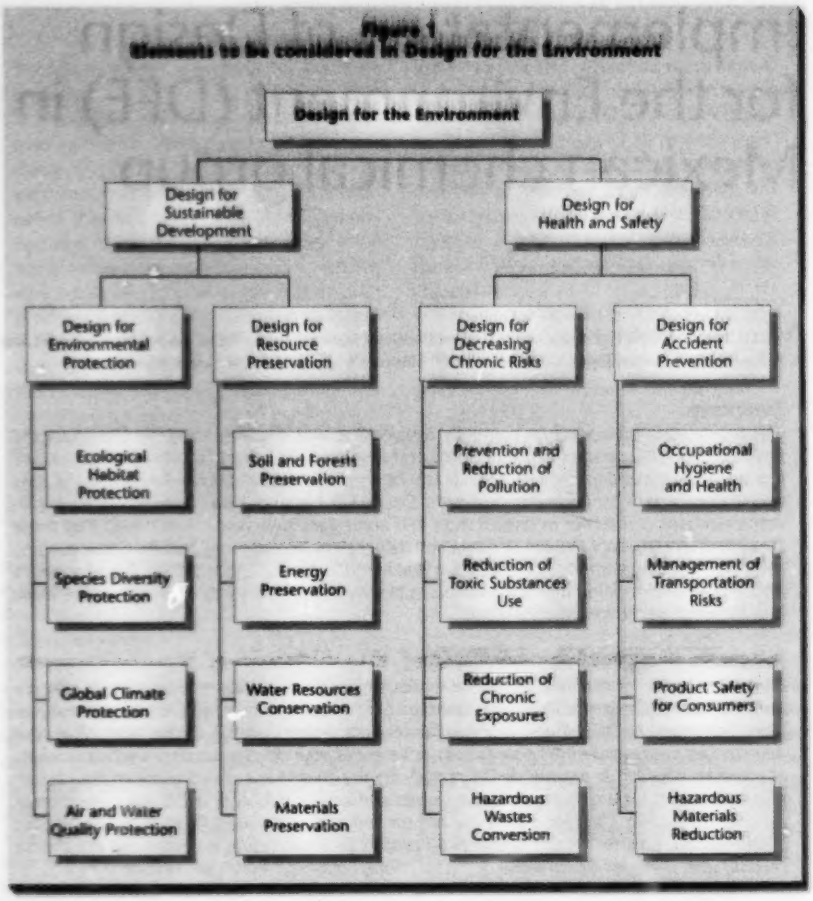
- systematic detection of potential significant risks, which would be duly evaluated (with quantification of their environmental/economic impacts) in order to carry out effective decision-taking within the shortest time possible;
- development of new products and processes to
  - formulate proposals for new products in accordance with customer requirements;
  - take into account the cost and performance of optimal processes and products from the point of view of sustainability;
  - draw up competitive strategy guidelines;
  - carry out technological development and product launching at the lowest cost and within the shortest time practicable.

Once the Design for the Environment Handbook had been written, DfE was implemented in several stages to determine its effectiveness and level of acceptability.

DfE was implemented in business cases in order to progressively incorporate environmental considerations in the organization's strategic decision-making. The intention was to arrive at an *understanding* of the new concept, rather than merely securing agreement to the initiatives proposed and to the development of new products from the standpoint of sustainable development.

While the DfE culture has not yet been adopted across the whole organization, this work was the cornerstone of the new culture in R&D areas.

Figure 1
Elements to be considered in Design for the Environment



First stage: the DfE Handbook

Developing a DfE Handbook took over a year. It involved technological monitoring, together with selection and implementation of concepts that could generate value added. The Handbook outlines work to be done in the context of DfE at each stage of the research process, giving researchers' work an environmental perspective.

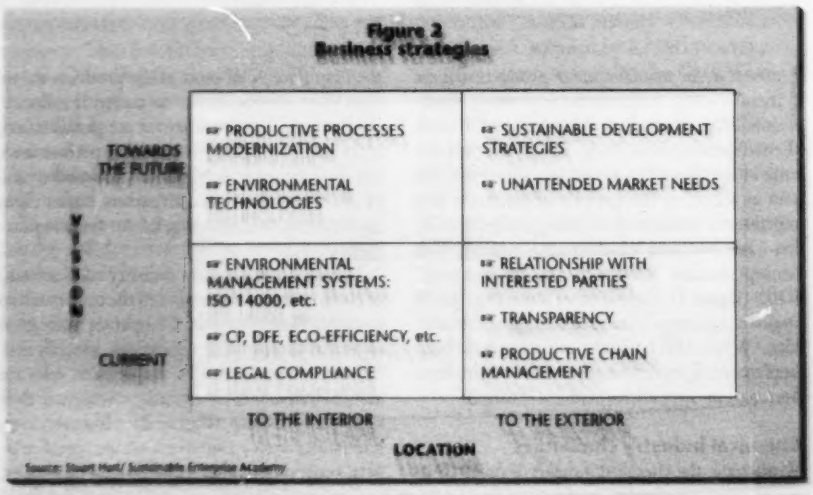
The Handbook introduces the user to topics such as sustainable development, environmental impacts, and the life cycles of products and processes. Numerous references to sources of further information are provided, and users are encouraged to refer to them.

An analysis of projects in the laboratory and at the pilot plant and industrial stages is provided, demonstrating how the DfE concept can be increasingly implemented. At each stage DfE can be approached from various perspectives. However, DfE implementation is always aimed at maintaining a balance among three elements: environmental considerations, social impacts and product profitability. The use of indicators is unavoidable.

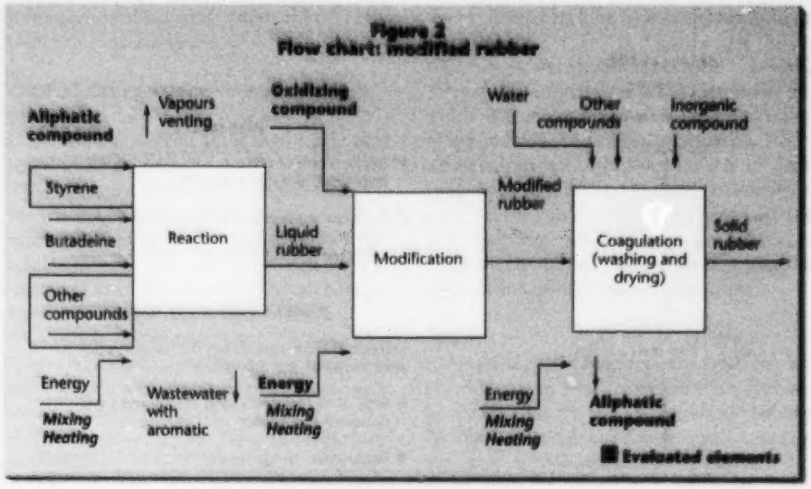
Second stage: selecting a project as a business case

A project was then chosen as a business case. This project was at an advanced phase: research had reached the laboratory level. In the context of DfE, the need to replace one raw material with another that posed less risk was identified. Replacement was not a simple matter. Experimentation went on for several months. As far as the researcher in charge of finding new alternate materials was concerned, the most persuasive arguments for making a change were: the long-term view; the preference for green products on European markets; and savings in terms of facilities where less protection and control equipment would be needed. Eventually, she found a feasible new material. While she had never acknowledged that she might agree to change materials, in the end a new material was found that was completely safe. Tests with respect to equalling or improving product performance still remain to be carried out. The work is still ongoing, but the fact that the leading researcher was convinced of the need for change represents a substantial achievement.

Figure 2
Business strategies



Source: Stuart Hart/ Sustainable Enterprise Academy



This business case (described in greater detail below) lasted almost a year, involving continuous interaction with the researcher, sharing of technical information and making her more aware of environmental considerations.

Business case: solvent-based adhesives

Solvent-based adhesives are solvent and resin mixtures that harden as the solvent evaporates. The use of polyurethanes in adhesives has several advantages, such as good adhesion to metal and or to paper sheets and heat resistance.

Most adhesives, including polyurethane ones, are formulated with some solvents, either VOCs (volatile organic compounds) or HAPs (hazardous air pollutants). The most common solvents used in formulating adhesives are hexane, methylethylcetone, phenol, toluene, xylenes and thinner.

Worldwide regulatory requirements are leading to the substitution of a number of chemicals. In the case of adhesives, one option is to use less of these products. Another is to find alternate solvents not included on the list of VOCs or HAPs.[2]

In the United States, the DfE Adhesives Technologies Partnership Program looks for solvents or alternate technologies that could be developed for the purpose of mitigating health and environmental impacts resulting from these products' use.[3]

Work consisted of characterizing the materials currently being used and identifying replacements if necessary. In this instance, removal of a toxic aromatic compound was proposed.

Environmental and safety benefits

The environmental and safety benefits of using a different material were:

- reduction in the pollution burden on subsoil due to waste from the manufacturing process, as well as to the packaging in which solvent is marketed, as toxic waste disposal (including the containers) is to landfill;
- not increasing generation of photochemical smog; elimination of emissions of organic vapour;
- improved product safety, eliminating the risk to the user arising from vapour emissions of residual solvent.

Social aspects

Social aspects were:

- reduction of chronic exposure to personnel;
- elimination of community risks related to transport of the solvent;
- development of a product for consumption by children that is free of toxic compounds.

Product profitability

Both the solvent and the replacement material are imported. The cost of the replacement material was much lower; forming links with the new foreign supplier had economic benefits.

Capitalizing on experience for use in education

Conclusions reached for this stage are:

- The major difficulty with incorporating DfE in researchers' work is that their paradigm of thinking in terms of product performance alone has to be changed. Making researchers aware of the life cycle concept is a good way to encourage them to broaden their vision of new product design;
- At the beginning, researchers refused to recognize the value added by DfE. It was eventually implemented as a result of their own convictions;
- Thinking environmentally added to the difficulty of researchers' work at first, but they came to feel satisfied about the product's more comprehensive design.

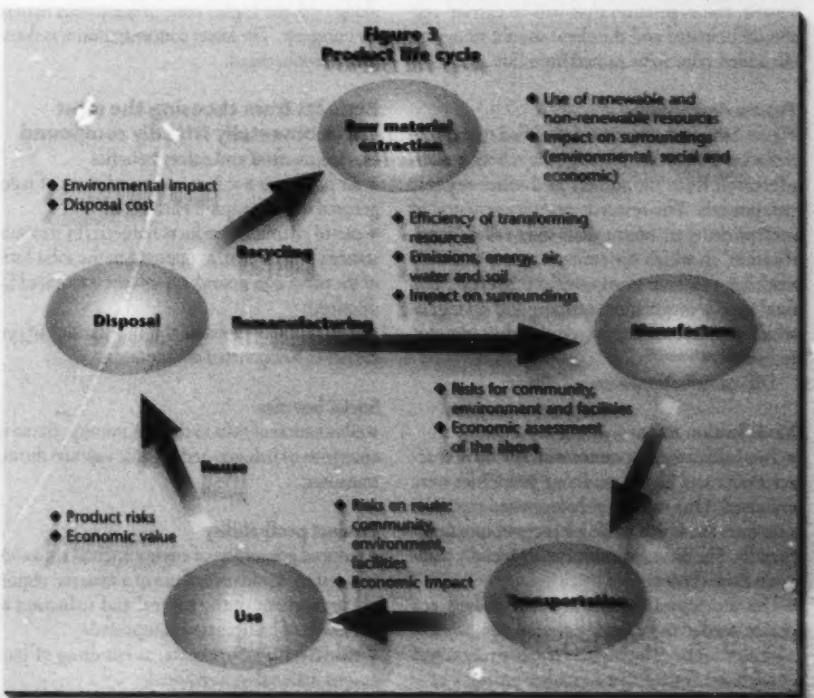
When researchers allow themselves to seek alternatives, these alternatives can be found. First of all, however, they must be convinced that there is such a need, and this may take months.

Third stage: Progressive DfE implementation

In the third stage, two ongoing technological projects were chosen: one in the pilot phase (**Figure 2**) and the other in the commercial phase.

In accordance with the outcome of the second stage, where the need to educate people about DfE was identified, the strategy chosen was to appoint a DfE-trained engineer to follow the researchers closely in their tasks and to identify environmental opportunities. Working from the standpoint of the product's life cycle (**Figure 3**) was a novelty for the researchers.

The most difficult barrier to overcome in constructing a bridge for communication between researchers and the DfE advisor was the researchers' feeling of ownership of their work. Communication slowly began to flow once the researchers recognized that DfE could enrich what they do. At the end of this stage, the advisor was required for many more tasks, not only those



related to projects that were part of the case study but also routine experimentation where environmental considerations needed to be taken into account. This advisor-researcher interaction was very useful. However, the company's organizational structures (taking advantage of synergies, multifunctionalism) led to the decision that researchers themselves should be the driving force behind DfE implementation while the divisional group advised on specific aspects.

During this stage of the research process, a group that had not been expected to be an active participant in DfE implementation became important: those actually operating the pilot plant. Once the researcher defines the formulations, plant operations become the responsibility of other personnel. The pilot plant's activities were focused on identifying opportunities to optimize materials and energy through cleaner production. Cleaner production is an extremely useful tool for identifying eco-efficiency opportunities.[4]

The equipment designed for experimentation at the pilot stage is usually adequate for the researchers' routine tests, but it was not entirely adequate for the measurements required by DfE. Thus, the advisor made several theoretical computations that resulted in difficult and extended work. While the advisor played an important role in DfE implementation, plant personnel should perform these tasks in future work.

Results obtained at subsequent stages are summarized in **Figure 4**. Each stage lasted two full years.

Regarding the project that was in its commercial phase, no progress was possible. Some concern exists about involving the client in something new and presenting it to him upon completion of research. Clients should be involved in DfE from the very beginning; when initial research is presented, the evaluation that will be carried out should be stated and the client should recognize the added value to be gained from DfE.

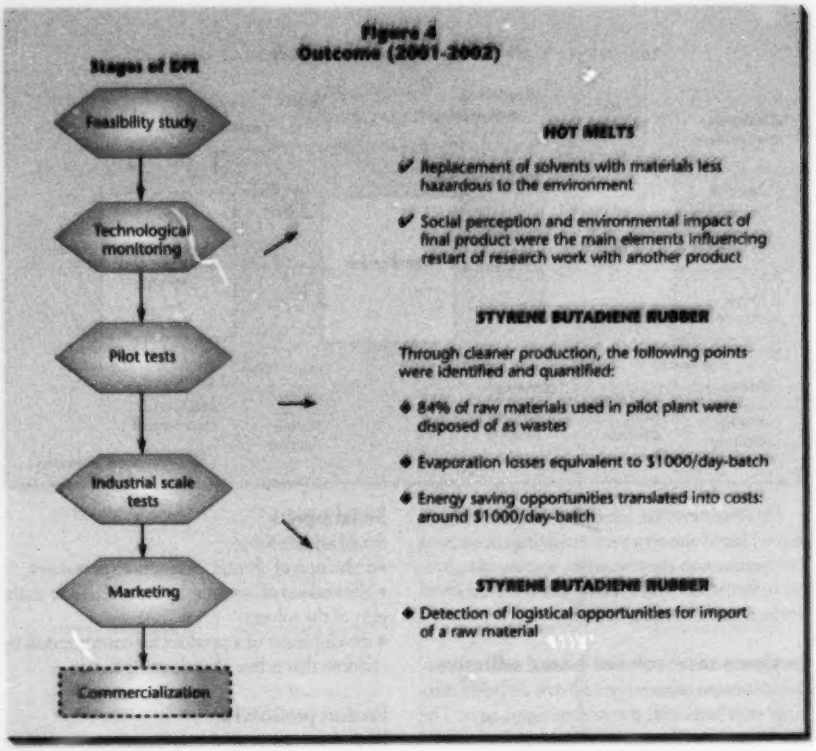


Figure 4
Outcome (2001-2002)
Stages of DfE
Feasibility study
Technological monitoring
Pilot tests
Industrial scale tests
Marketing
Commercialization
HOT MELTS
✔ Replacement of solvents with materials less hazardous to the environment
✔ Social perception and environmental impact of final product were the main elements influencing restart of research work with another product
STYRENE BUTADIENE RUBBER
Through cleaner production, the following points were identified and quantified:
◆ 84% of raw materials used in pilot plant were disposed of as wastes
◆ Evaporation losses equivalent to $1000/day-batch
◆ Energy saving opportunities translated into costs: around $1000/day-batch
STYRENE BUTADIENE RUBBER
◆ Detection of logistical opportunities for import of a raw material

Process description

Figure 2 shows the process of modified rubber formulation. In the reaction stage the rubber is manufactured from monomers and other organic compounds. The research project consisted of incorporating an intermediate stage called "modification" in which the rubber is modified with oxidizing processes to improve its properties. The final stage is coagulation, washing and drying, in which aliphatic solvent (a type of hydrocarbon) is recovered.

DfE contributions were as follows:

Modification stage

◆ Two oxidative compounds with corrosive characteristics and highly oxidizing properties were evaluated. One contained halogenated materials as impurities, which made it less environmentally friendly. The most environmentally friendly compound was chosen.

◆ This compound was submitted for analysis, as a choice needed to be made between two possible concentrations. The highest concentration was considered feasible, as a smaller amount of it would be required in the process. However, at 35% concentration the compound showed hazardous characteristics; at a concentration of 30% it presented no hazard. The lower concentration necessitated the use of a greater amount of the compound. As it was non-hazardous, the risk to communities during transport was eliminated, along with the higher costs of hazardous materials transport. The lower concentration was therefore recommended.

Benefits from choosing the most environmentally friendly compound

Environmental and safety benefits

◆ air pollution not increased; emissions of halogenated organic vapour eliminated;

◆ use of chemical products reduced (in this substance's liquid form, as opposed to the solid form of the other compound, no solvent is required for dilution);

◆ elimination of probable chronic exposure of personnel to halogenated compounds;

Social benefits

◆ elimination of risks to the community related to emissions of halogenated organic vapours during transport;

Product profitability

◆ reduced generation of environmental emissions (air, water); avoidance of use of a material requiring investment in the control and reduction of emissions of halogenated compounds;

◆ reduced transport costs, as handling of hazardous materials not required;

Benefits gained when the lower concentration is chosen

Environmental and safety benefits

◆ hazardous waste reduction, as 84% of the oxidant consumed eliminated as waste;

◆ reduced consumption of chemical compounds required to treat wastewater produced by excessive acid consumption;

◆ reduction of risks to workers during product handling;

Benefits for the pilot plant process

Energy

◆ pilot tests carried out at same location where rubber is manufactured (Altamira), to take advantage of heat generated during the process and to avoid additional consumption of energy at the plant during the modification stage;

Product profitability

◆ energy consumption savings if the pilot test is carried out at the same location where rubber manufactured;

Benefits at the coagulation stage

Environmental and safety benefits

◆ no increased generation of photochemical smog; emissions of organic vapours of the aliphatic solvent eliminated at pilot plant;

Product profitability

◆ considerable savings opportunities due to identification of losses (around 90% of aliphatic solvent when separated by evaporation during coagulation stage, due to faulty operation during

its recovery); it is necessary to modify the pilot plant to avoid these losses.

Capitalizing on experience for use in education

Conclusions at the end of the third stage can be summarized as follows:

- Incorporating DfE concepts requires a link to the researchers' work if this technology is to be incorporated in a practical way. Under the DfE scheme they not only learn, but a total transformation of their beliefs occurs (with an environmental vision now basic to their work);
- Of course, it is also necessary that researchers learn about the subject through reading and, above all, attending forums where they can share experience with their peers;
- A change in pilot plant structures follows the incorporation of DfE in research; use of a greater number of instruments to ease the measuring work is considered;
- DFE is a synergy tool; not only should plant personnel be looking for savings opportunities, but for researchers it becomes a hypothesis to be corroborated;
- Clients are of strategic importance. They will drive environmental work when they realize the added value it provides in terms of market value, image and environmental performance. When clients are unaware of these benefits, it is up to the company to make the clients sensitive to them. That is the only way for the value added resulting from DfE implementation to be recognized. Clients, in turn, can commercialize the new product using the same environmentally related information.

Notes

1. See *Industry and Environment* review, Vol. 25, No. 3-4 (cleaner production issue, July-December 2002), Glossary, p. 3, and *passim*; and Volume 26, No. 2-3 (sustainable building and construction issue, April-September 2003), *passim*.
2. There are many sources of information concerning the substances on these lists. See, for example, the site of the American Solvents Council (www.americansolventscouncil.org/faqs.asp).
3. www.epa.gov/dfe/pubs/tools/ dfefactsheet/dfefacts8_02.pdf.
4. See the article by Mily Cortés Posas and Nonita T. Yap on page 68.

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A Danish company's use of Best Available Techniques for waste handling and treatment

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Summary

In the context of the Directive on Integrated Pollution Prevention and Control, the Danish company Kommunekemi has contributed to the elaboration of a EU reference document on Best Available Techniques for safer handling and treatment of hazardous waste. Several years ago Kommunekemi faced environmental impact and occupational health and safety problems. Two new automatic drum-emptying systems (one for liquid waste, the other for solid and pasty waste) were installed in the 1990s. This article describes the processes used to improve environmental and safety conditions at and around Kommunekemi's facility.

Résumé

Dans le cadre de la Directive relative à la prévention et à la réduction intégrées de la pollution, l'entreprise danoise Kommunekemi a participé à l'élaboration d'un document de référence de l'UE sur les meilleures techniques pour une manipulation et un traitement plus sûrs des déchets dangereux. Cette entreprise avait été confrontée il y a plusieurs années à des problèmes d'impacts sur l'environnement, d'hygiène et de sécurité du travail. Deux nouveaux systèmes automatiques de vidange de fûts (un pour les déchets liquides, l'autre pour les déchets solides et pâteux) ont été installés dans les années 1990. L'article décrit les procédés employés pour améliorer l'état de l'environnement et les conditions de sécurité à l'intérieur de l'usine et dans les environs.

Resumen

En el marco de la Directiva sobre Prevención y Control Integrales de la Contaminación, la empresa danesa Kommunekemi ha contribuido a la preparación de un documento de referencia de la UE sobre las mejores técnicas disponibles para el manejo y tratamiento seguros de los desechos peligros. Hace varios años Kommunekemi enfrentó problemas de impacto ambiental y salud y seguridad ocupacional. En la década de 1990 se instalaron dos nuevos sistemas automáticos de tambor de vaciado (uno para desechos líquidos y otro para desechos sólidos y de consistencia pastosa). Este artículo describe los procesos empleados a fin de mejorar las condiciones ambientales y de seguridad en el interior y los alrededores de las instalaciones de Kommunekemi.

The European Union's Integrated Pollution Prevention and Control (IPPC) Directive, adopted in 1996, provides a framework for issuing operating permits to installations that carry out the types of industrial activities described in Annex 1 to the Directive.[1] These permits are to set out conditions based on Best Available Techniques (BAT), as these are defined in the Directive, to achieve a high level of protection of the environment as a whole.

The European IPPC Bureau[2] catalyzes the exchange of technical information on Best Available Techniques. It creates reference documents (BREFs) which Member States are required to take into account in when they determine conditions for the delivery of operating permits. BREFs inform decision-makers about what may be technically and economically available to industry to improve environmental performance.

In the spring of 2004 the IPPC Bureau proposed the elaboration of a BREF describing the different techniques used to treat waste in EU countries. Kommunekemi[3] contributed to the draft BREF on hazardous waste incineration by describing some special pre-treatment and flue gas cleaning operations.

Kommunekemi is located east of the city of Nyborg, Denmark, within ten metres of a golf course. It is next to a food producing company; to the north is a public camping site near a beach. Kommunekemi's location puts a focus on the use of Best Available Techniques concurrently with the company's development.

Today Kommunekemi has three modern rotary kiln plants with a total annual treatment capacity of 180,000 tonnes of hazardous waste. In 2003 it received and treated well over 120,000 tonnes of hazardous waste from Denmark and abroad.

Along with the development of the incineration facility, there has been a focus on developing pre-treatment plant and possible recycling techniques and the utilization of heat from the processes. These processes are described below. Great attention is continuously paid to emissions monitoring and to off-gas ventilation from storage tanks, etc.

The drum-emptying systems

For several years all packaged liquid waste for incineration was manually emptied into a vacuum tank, using a hose, and then pumped to storage tanks. Solid packaged waste was manually cut up and subdivided into portions a maximum of 100 kilograms in size. Drums containing the waste were then fed directly into the rotary kilns.

However, the plant faced a series of problems concerning the external environment and occupational health and safety. These resulted in the establishment of two new automatic drum-emptying systems in the 1990s, one for liquid waste and the other for solid and pasty waste.

The drum-emptying system for liquid waste

The original plant for emptying liquid waste was replaced by a closed, automatic plant (**Figure 1**) in which drums and other packaging with liquid contents are cut up into fragments in a double shredder.

Packaging is carried on a roller conveyor from the reception and unloading area to the feeding sluice. At this stage individual packaging is identified by bar codes. The process control system ensures that waste has been approved for treatment at the plant. The feeding sluice is flushed with nitrogen until the danger of an explosion is eliminated. Packaging then slides into the shredder, where it is cut up into 5-10 centimetre fragments.

After thorough mixing, small pieces of packaging are sorted using a sieve. A magnetic separator divides them into magnetic and non-magnetic scrap. The magnetic fraction is washed and delivered to a steel mill for recycling. The non-magnetic fraction, consisting mainly of plastic, wooden and other parts that cannot be dissolved, is incinerated in rotary kilns.

Having passed the sieve, the liquid waste is further homogenized and continuously stirred to

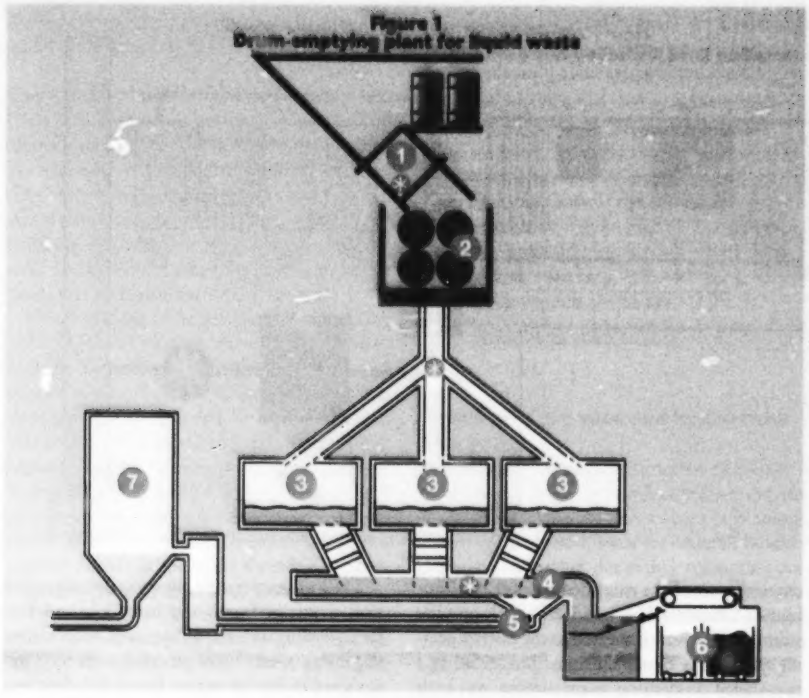


Figure 1
Drum-emptying plant for liquid waste

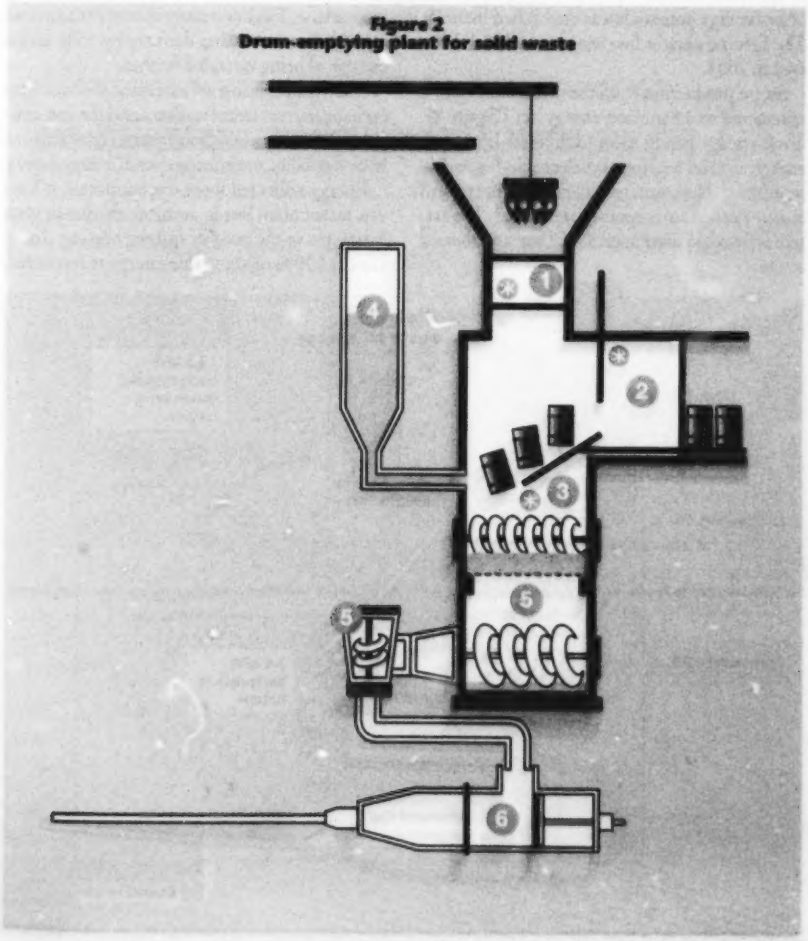


Figure 2
Drum-emptying plant for solid waste

avoid settling. The mixture is finally pumped to 15,000 m^3 storage tank farms. Capacity is increased by 40,000 m^3 external storage facilities in Copenhagen.

For safety reasons, the plant is completely flushed with nitrogen to reduce the oxygen level (which must be under 8%). Thus the gas phase in the plant cannot explode.

The plant has been in operation since 1990. It has a treatment capacity of approximately 3.5 tonnes of packaged liquid waste per hour, or approximately 7000 tonnes per year for one shift. Approximately 10% of this amount is steel scrap, which is recycled.

The drum-emptying system for solid waste

The solid portion of the packaged waste was still incinerated in the rotary kilns directly in the packaging, as it could not be treated in the drum-emptying system for liquid waste. However, Kommunekemi still had a distinct need for plant to empty, homogenize and continuously feed the packaged solid waste.

In 1996 an automatic system for handling and emptying solid and pasty packaged waste was built. In principle, this plant (**Figure 2**) is similar to the liquid plant. However, it is of course of much heavier construction.

The waste is transferred from storage areas to a roller conveyor. Again, individual waste is identified by bar codes and the process control system ensures that it has been approved for treatment.

Waste and packaging are transferred to the plant by a sluice flushed with nitrogen. A batch of waste, typically five to seven pallets with packaged solid waste, is crushed in the crushing chamber, where viscosity is adjusted up or down by mixing in special waste fractions. From the crushing chamber the batch is pumped, using heavy piston pumps, through the front shield and into the rotary kilns.

At this plant there is no separation of steel scrap for recycling, as the mixture is unable to pass a sieve in the same way as at the "liquid plant". The steel is oxidized during incineration and then incorporated in the bottom slag from the rotary kilns.

For safety reasons, the plant is completely flushed with nitrogen to reduce the oxygen level (which must be under 8%). Thus the gas phase cannot explode.

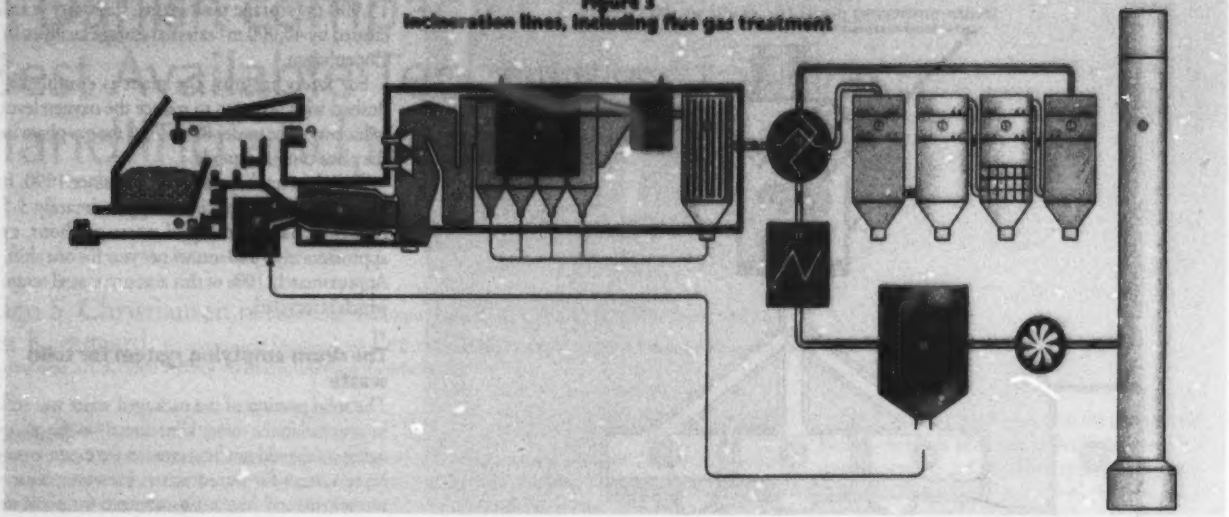
The treatment capacity of the drum-emptying plant for solid waste is 1.5 tonnes of waste per hour, or similar to approximately 12,000 tonnes annually in five shifts.

Improved environment and safety conditions

Establishment of the automatic drum-emptying systems has resulted in a number of improvements in environmental and safety conditions at Kommunekemi:

- Occupational health and safety problems related to manual handling and emptying of packaged waste have been reduced to a minimum;
- Employees' contact with hazardous substances

Figure 3
Incineration lines, including flue gas treatment



in waste during emptying has practically been eliminated;
- It is possible to recycle part of the steel from packaging before it goes to the incineration plants;
- More homogenous feeding of waste to incineration plants has made possible better energy utilization and lower emissions to air;
- Feeding waste in a regular flow makes better waste combustion possible, and it increases the lifetime of the refractory in the kilns since there is less wearing by the steel drums.

Kommunekemi decided not to treat poisonous and reactive substances in the drum-emptying systems. This decision was made in order to reduce the risk of accidents during operation and to reduce human health risk during repair and maintenance.

Waste incineration

Kommunekemi's core business is incineration of hazardous waste. It operates three rotary kiln incineration lines, all equipped with the necessary flue gas cleaning device as required by EU and local Danish legislation. Beyond the legal requirements, incineration lines (**Figure 3**) are equipped with some additional facilities:
- a system of steam turbines and heat exchangers to produce district heating;
- incineration of ventilation gases from the tank farm, drum-emptying plants, waste bunkers, unloading facilities for road tankers, etc.;
- a special wet scrubber for removal of bromine and iodine from flue gases.

Energy recovery

Kommunekemi has had long experience with waste heat utilization, starting with the first incinerator line in 1975 (where a steam boiler reduced the temperature of waste flue gas, thus ensuring the internal energy needed for waste pre-treatment). Spare steam was connected to a heat exchanger for district heating purposes. The second line with heat recovery was built in 1983. The size of the steam boiler was slightly increased by entering part of the extended Secondary Combustion Chamber (SCC). In 1985 a back-pressure steam turbine was connected to the district heating system. The third incinerator line, including a two-staged condensing steam turbine, was built in 1989. A system for collection and distribution of low energy potentials was established in 1995. The first incinerator line was renewed and delivered in 2003.

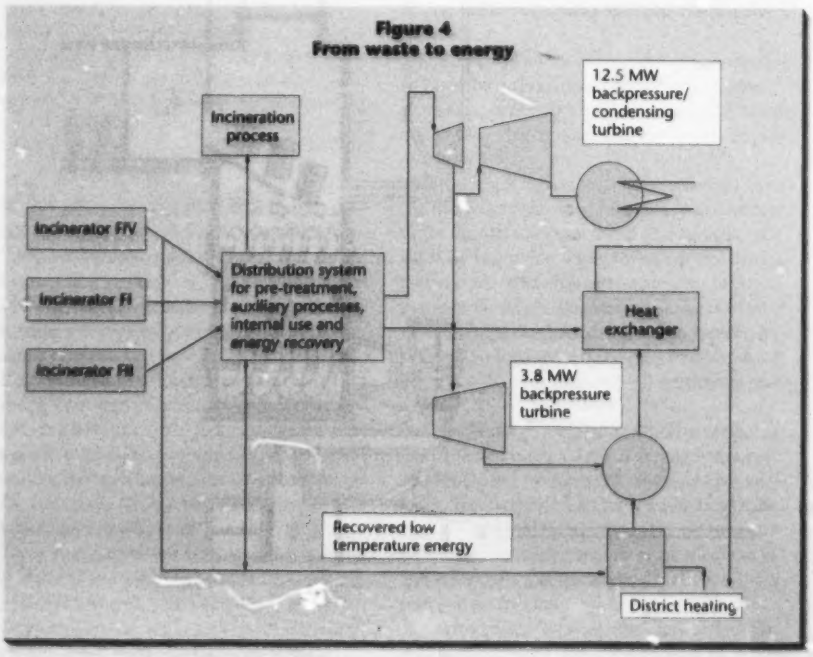
Steam production from the incinerator lines is connected to a common energy net (**Figure 4**). Total energy production (delivered as process energy, district heating and electricity) is widely monitored. Net steam production and the type of energy needed are constantly optimized. The system is based on combined 35/12 bar superheated steam.

The low-temperature energy collecting system receives energy from water-based kiln and front shield cooling systems, compressors, economizers, slag outputs, etc. These processes were originally designed to free air energy losses, but they were rebuilt for additional district heat delivery and internal use. The low-energy system has increased annual district heating delivery by 15% and is capable of being extended further.

The combination of extended district heat exchangers, two steam turbines and the low-temperature energy collection system contributes to wide flexibility, optimizing overall energy export.

Energy collected from the incineration lines was earlier often lost to ambient air, due to great variations in the need of district heating. Today almost 100% of accessible energy is recovered.

Figure 4
From waste to energy



Annual energy export is approximately 160 GWh as district heating and 50 GWh as electricity.

The off-air plant

Even very low concentrations of volatiles will often create unacceptable odours, causing inconvenience with respect to the internal and (if the odours are strong) external environment. To deal effectively with local emissions of volatiles (e.g. hydrocarbons from unloading activities, processes in one of the drum-emptying plants), an "off-air plant" was established in 1993 (**Figure 5**).

Eleven sections of the plant area were defined, including about 50 spots where emissions would normally occur during operations. The pipe and control system from the off-air plant is widely spread throughout the whole area. Ventilated volatiles will effectively be sucked by the medium-pressure fan located near the incinerator plants. To maintain a constant gas flow, ventilated VOCs are mixed with ambient air, entering the suction part as the last input point. The fan distributes the volatiles further to one of the three SCCs, where high-temperature incineration takes place.

The closed system is designed for -200 to +400 mBar. It operates with a pressure of -80 to -100 mBar on the suction part and +50 to +150 mBar after the fan. The galvanized pipe system is designed to withstand a pressure of 10 bars.

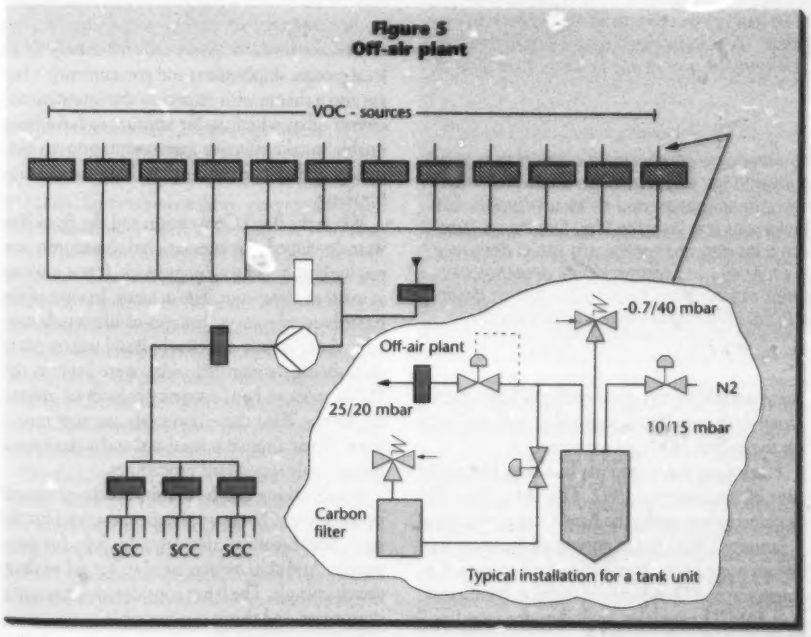
Differences in tank volumes (and thereby pressure) during filling and emptying periods are regulated in such a way that the off-air plant will ventilate the compressed tank gases in the ratio 25/20 mBar, and the inert supply system will add nitrogen in the ratio 10/15 mBar.

To eliminate potential risk of flame propagation, the ex-proof system is equipped with more than 50 static flame arresters, redundant monitoring equipment, etc. The off-air plant is designed to a minimum velocity of 17 metres/second and the SCC nozzles ensure a minimum velocity of 55 metres/second.

Removal of bromine and iodine from flue gases

When waste containing bromine or iodine is incinerated, the flue gas will contain these substances, which are brown and purple in colour. There are no official EU flue gas limits for bromine and iodine. However, due to their colour they cannot be accepted in the flue gas. Kommunekemi has therefore installed special bromine/iodine cleaning columns in all three incineration lines. Bromine/iodine cleaning works as follows:

Figure 5
Off-air plant



$$Br_2 + SO_3^{2-} + H_2O \longrightarrow 2Br^- + SO_4^{2-} + 2H^+ \quad (1)$$

and

$$I_2 + SO_3^{2-} + H_2O \longrightarrow 2I^- + SO_4^{2-} + 2H^+ \quad (2)$$

From the chemical reaction, it can be seen that the reduction of bromine/iodine to bromide and iodide causes lower pH and sodium hydroxide must therefore be added to keep the pH at approximately 7.5.

Unfortunately the sulphite will also be consumed by the remaining oxygen (approximately 10 %) in the flue gas:

$$O_2 + 2SO_3^{2-} \longrightarrow 2SO_4^{2-} \quad (3)$$

This reaction does not cause any change in pH. However, expensive raw material (sodium sulphite) is consumed without any useful effect on the process.

Exactly similar chemical reactions will also take place in the SO_2 scrubber (i.e. when the concentration of SO_2 in the flue gas is high enough, there will be sufficient sulphite to reduce bromine/iodine to bromide and iodide). It can therefore be concluded that as long as the SO_2 load in the flue gas is high, there is no need for the bromine/iodine stage. However, it is Kommunekemi's experience that the sulphur content in hazardous waste has fallen during the last year, thereby creating a need for a bromine/iodine stage.

To reduce the amount of "wasted" sulphite, as described in chemical reaction (3) above, an automatic analyzing device for bromine and iodine has been installed in clean flue gas lines. When the bromide concentration exceeds 40 mg/Nm^3 or iodine exceeds 80 mg/Nm^3 (both levels clearly below the visible levels), the bromine stage automatically starts. Immediately afterward, the concentration of bromine and iodine in the cleaned flue gas will begin to decrease.

Notes

1. Directive 96/61. See http://europa.eu.int/comm/environment/ippc/index.htm, and (for Annex) http://eippcb.jrc.es/pages/Directive.htm#annex
2. See http://eippcb.jrc.es.
3. Kommunekemi a/s was established in Nyborg, Denmark, in 1971. It collects and treats hazardous waste from industries and households. The company produces and delivers almost 100% of the district heat used in the city of Nyborg and 15-20% of that city's electricity consumption. ◆

Shipbreaking and e-waste: the international trade in hazardous waste continues

Kevin Stairs,

Summary

Far more resources are needed worldwide to reduce/eliminate the generation of hazardous materials and products. Ever-increasing hazardous waste generation in developed countries needs to be curtailed by making substitution mandatory. Current hazardous waste recycling practices are unsustainable. Two of the most important hazardous waste trade issues today are shipbreaking (which often occurs in Asian breaking yards) and exports of electronic waste from the most highly industrialized countries to developing countries for processing. Each of these activities has serious impacts on human health and the environment.

Resumé

Il faudrait mobiliser beaucoup plus de ressources au niveau mondial pour réduire, voire faire cesser la production de matières et produits dangereux. Dans les pays développés, il faut freiner la production croissante de déchets dangereux par des mesures rendant obligatoire le recours à des produits et procédés de substitution. Les pratiques actuelles de recyclage des déchets dangereux sont incompatibles avec le développement durable. Deux des principaux problèmes que pose actuellement le commerce des déchets dangereux sont la démolition des navires (souvent dans des chantiers de démolition en Asie) et les exportations de déchets électroniques des pays les plus industrialisés vers les pays en développement pour transformation. Chacune de ces activités a des conséquences extrêmement graves sur la santé humaine et l'environnement.

Resumen

Se requiere de muchos más recursos para reducir o eliminar la generación de materiales y productos peligrosos alrededor del mundo. Es necesario restringir la creciente generación de desechos peligrosos en los países desarrollados mediante la obligatoriedad de la sustitución. Las prácticas actuales para el reciclaje de desechos peligrosos son insostenibles. Dos de las cuestiones más importantes en la actualidad en cuanto a los desechos peligrosos son el desguace marítimo (que suele ocurrir en áreas de desguace en Asia) y la exportación de desechos electrónicos para su procesamiento desde los países más industrializados hacia países en desarrollo. Ambas actividades tienen graves efectos en la salud humana y el medio ambiente.

Shipbreaking: a form of hazardous waste trade

TOXICS
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should no longer be seen as a lucrative market in which ship owners and ship brokers profit from externalizing toxic pollution costs, but as a service carried out by the shipbreaking countries – a service the world needs and which should not be subject to the liabilities associated with the handling and disposal of toxic and hazardous waste. These are burdens to be borne by shipping companies, which are the "purchasers" of the service.

Greenpeace is in favour of introducing an international shipbreaking fund, paid for by shipping companies, together with the development of mandatory global rules requiring ship owners to take responsibility for toxic waste on their ships and the safe breaking of these ships.

The high-tech trashing of China

A new form of hazardous waste trade is associated with the rapid development of the electronics industry. In 1998 it was estimated that 20 million computers had become obsolete in the United States, and that the overall volume of e-waste was 5 to 7 million tonnes. According to the report *Exporting Harm: The High-Tech Trashing of Asia*,[8] well-informed industry insiders have indicated that around 80% of electronic waste generated in the US will be exported to Asia, of which 90% is destined for China.

In December of 2001 the Basel Action Network (BAN), with the logistic support of Greenpeace, carried out an investigation to observe at first hand the recycling conditions for imported e-waste in China. It was discovered that Guiyu, about an hour's drive west of Shantou City in the Chaozhou region of the greater Guangdong Province, is one of the e-waste hotspots. Since 1995 Guiyu has been transformed from a poor, rural, rice-growing community into a booming e-waste processing centre. While rice is still grown, virtually all the available building space is occupied by hundreds of small, often specialized e-waste recycling shelters and yards.

Chinese press accounts have estimated that 100,000 people are employed in the e-waste sector at Guiyu. However, such an estimate would be extremely difficult to make in view of the fluctuating migrant workforce. It would be virtually impossible to estimate how much e-waste is processed there annually. An anecdotal observation is that there is very high turnover, with hundreds of trucks moving in and out daily and a steady rumble and buzz of activity. These observations have led us to conclude that Guiyu is a significant destination for the world's e-waste. From the institutional labels, markings, maintenance stickers and phone numbers on the computers and peripheral units it is quite easy to determine the source of this e-waste. Most is clearly of North American origin, with Japanese, South Korean and European waste present to a lesser extent.

Many workers are women and children. For the menial jobs of dismantling and processing imported e-waste, the average wage equals US$ 1.50 per day. This wage is accepted by the population and workforce, while people are unaware of the hidden health threats. Since the groundwater is polluted, water has to be trucked from the town of Ninjing 30 kilometres away.

Most activities in Guiyu involve physical dismantling with hammers, chisels, screwdrivers and bare hands. The most high-tech piece of dismantling equipment seen was an electric drill. The immediate objective of most operations is the rapid separation of primary materials.

Workers without any protective respiratory equipment (or special clothing of any kind) open cartridges using screwdrivers and then wipe toner into a bucket using brushes or their bare hands. In the process of dismantling computers, a considerable amount of material is collected and dumped outside the town along the river, where many of

Fighting environmental crime and protecting the environment: UNEP's Green Customs Initiative

Environmental crime is a big and increasingly lucrative business – a multi-billion dollar global enterprise. Local and international crime syndicates worldwide earn an estimated US$ 22-31 billion dollars per year from hazardous waste dumping, smuggling of proscribed hazardous materials, and exploitation and trafficking of protected natural resources. Illegal trade in commodities such as ozone depleting substances (ODS), toxic chemicals, hazardous waste and endangered species is an international problem with serious consequences. It directly threatens human health and the environment, contributes to species loss, and results in decreased revenues for governments.

Illegal trade in environmentally sensitive commodities strengthens criminal organizations that also traffic in drugs, weapons and prostitution. It seriously undermines the effectiveness of multilateral environmental agreements (MEAs) by circumventing agreed rules and procedures.

National and international regimes for integrated chemical management rely on customs authorities to monitor and control flows of regulated chemicals across borders. International agreements related to chemical management often restrict specific chemicals' supply and demand at the national level; some agreements concern phase-outs of harmful substances. Where illegal trade occurs, incentives for chemicals control and phase-outs established in MEAs are considerably weakened. National customs authorities need the capacity to monitor the chemicals covered by MEAs.

Facts about environmental crime: criminal organizations' estimated annual earnings from environmental crime

Estimated amount (US$ billion)	Type of activity
10-20	Dumping of trash and toxic materials
6-10	Illegal trade in endangered species and animal parts
5-8	Theft of and illicit trade in natural resources, including illegal logging and trade in forest timber
1-2	Illegal trade in ODS
Criminal activity related to ozone depleting substances	
20,000-30,000 metric tonnes	Estimated size of global black market for ODS
10,000-20,000 metric tonnes	Amount of CFCs smuggled into the United States each year, as reported by US Customs
US$ 600 million	Amount ODS smugglers earn annually from selling to buyers in Europe and North America, as estimated by industry in 1998
US$ 150 million	Amount of annual excise tax revenues the US government loses as a result of ODS smuggling, as estimated by industry in 1998

Source: International Crime Threat Assessment, December 2000 (http://clinton4.nara.gov/WH/EOP/NSC/html/documents/pub45270/pub45270index.html)

Context

The issue of coordinating MEA implementation is high on the international agenda. Parties to such agreements (whether they contribute to financing or have responsibilities for making agreements work on the ground) want to achieve synergies between treaties, improve cost-effectiveness and ensure compliance with MEA objectives. Coordination has been emphasized repeatedly at international environmental meetings. International organizations and convention secretariats all recognize the need to undertake activities that translate their desire for complementarity into actions on the ground.

The illegal trade issue affects most MEAs with trade components. In each case it will be necessary to work with national and regional customs agencies to combat such traffic. Many of the problems and solutions are similar. Therefore, cooperation on illegal trade is an excellent opportunity for international organizations and MEA secretariats to work together on issues in different areas. UNEP's Governing Council has made the link between the need to promote cooperation between different Conventions and the importance of addressing illegal trade in environmentally sensitive commodities.

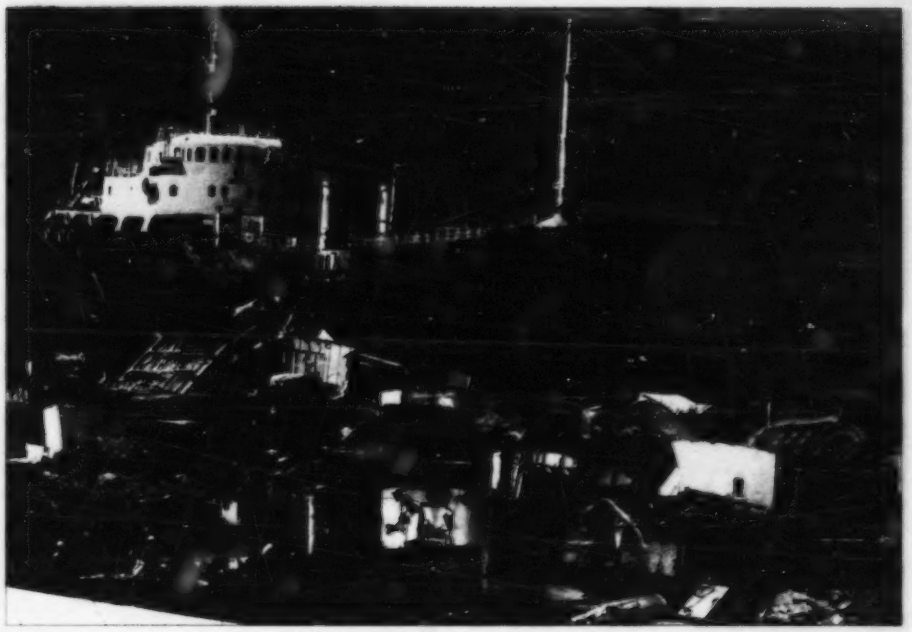
Response

Customs officers are on the front line with respect to national efforts to combat illegal trade. If an MEA is to be successful, these officers must be empowered, equipped and trained. For example, import/export licensing systems

the dirtier operations take place.

A small village where residents make their living entirely by burning wires to recover copper has existed there for two years. A landscape of black ash residue covers the ground and houses. Burning always takes place in the middle of the night, indicating that local authorities may have frowned upon this activity. It is extremely likely that due to the presence of PVC or brominated flame retardants in wire insulation, emissions and ash from burning these wires contain high levels of brominated and chlorinated dioxins and furans, two of the most deadly persistent organic pollutants (POPs). It is also probable that cancer-causing polycyclic aromatic hydrocarbons (PAHs) are present.

In a survey conducted by the Medical College of Shantou University and Greenpeace, it has been found that the e-waste "demanufacturing" industry in Guiyu impacts people's health by different degrees. Current e-waste treatment, such as circuit board incineration



Ship being dismantled in a shipbreaking yard

are the main way countries regulate ozone depleting chemicals crossing their borders. Without an effective monitoring and control system, they would most likely not be able to meet their international obligations to control specific trade under the Montreal Protocol. Their compliance will be at risk.

Active participation of trained customs officers in supporting the import/export licensing system is a cornerstone of national compliance strategies. Recognizing this fact, the Multilateral Fund for the Implementation of the Montreal Protocol supports specialized customs training with respect to ODS. UNEP's OzonAction Programme has designed and delivered over 80 national and regional customs training workshops related to the Montreal Protocol as part of that support.

Advantages of the Green Customs approach

For countries
- coordinated capacity building in regard to national customs officers
- efficient use of national human and financial resources
- deterrence of environmental crime
- assistance with national compliance under MEAs

For MEA secretariats
- cost-effective use of limited financial and human resources
- sharing of training infrastructure developed by secretariats
- improved, effective and sustained compliance with Conventions

For the global environment:
- "greening" of customs services
- decrease in environmental crime
- better and cleaner environment

Based on that experience, the OzonAction Programme has determined that there is great potential to achieve synergies by developing a customs training approach that involves not just the Montreal Protocol but other MEAs as well. In 2001 OzonAction developed and pioneered the "Green Customs" concept, under which integrated training encompassing several MEAs will be delivered to customs officers at the same time – developing their capacity more cost-effectively and efficiently than would separate training regarding each individual agreement.

The OzonAction Programme invited like-minded organizations to refine this concept. This eventually evolved into the Green Customs Initiative. Current partners include UNEP (the OzonAction Programme, as well as the Division of Environmental Conventions and the Division of Environmental Policy Implementation), Interpol (the international criminal police organization), WCO (the World Customs Organization) and the secretariats of MEAs with trade provisions, i.e. the Montreal Protocol, the Basel Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal, and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

Under this initiative, the partners are developing joint customs training. They also work to improve coordinated intelligence gathering, information exchange, and guidance such as codes of best practice.

Actions

The partners have undertaken a number of actions under this initiative:

Awareness and information

The Green Customs web site (www.uneptie.org/ozonaction/customs) makes information about the initiative available to the public, along with links to partners' web sites.

Institutional arrangements

In June 2003 a Memorandum of Understanding (MOU) was signed between UNEP and WCO to cooperate on Green Customs. In August 2003 another MOU between UNEP and India's National Academy of Customs, Excise and Narcotics (NACEN) created a regional Green Customs training centre in India.

Outreach

As part of the effort to share information across organizations, WCO invited UNEP to present the Green Customs initiative at the 23rd Meeting of the WCO Enforcement Committee in Brussels in February 2004. WCO/RILO (Regional Intelligence Liaison Office) representatives have participated in regional forums, including the UNEP-organized Illegal Trade Workshop in Syria. UNEP also participated in a workshop on Strengthening of Cooperation Based on Chemicals and Hazardous Wastes Conventions in Prague in March 2004.

Capacity building of regional trainers

Work has been undertaken to further strengthen the capacity of selected trainers to address the environmental compliance and monitoring issues of all secretariats.

continued on page 60 ☞

The World Customs Organization

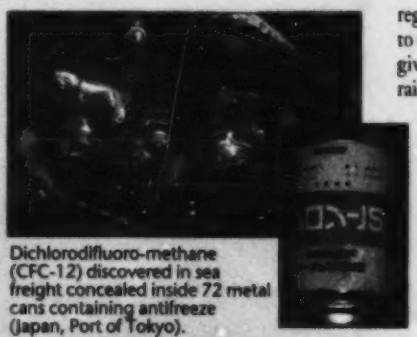
The role of customs administrations in environmental matters is to implement government policy so as to ensure compliance with the national and international regulations in force. It is therefore important that customs, as a law enforcement service, has appropriate and sufficient means to effectively combat this type of fraud.

The World Customs Organization (WCO), the only independent intergovernmental body with responsibility for customs matters, was established in 1952.[1] Its purpose is to enhance the effectiveness and efficiency of customs administrations and assist them in contributing to national development goals, particularly in the areas of trade facilitation, revenue collection, protection of society and the security of the international trade supply chain.

The WCO's 162 member customs administrations worldwide are collectively responsible for processing 98% of world trade.

In terms of environmental protection, the WCO wishes to take broad-based action insofar as its Secretariat Directorates are directly involved:

- the Tariff and Trade Affairs Directorate deals with the Harmonized System aspect;
- the Compliance and Facilitation Directorate deals with enforcement and customs modernization.



Dichlorodifluoro-methane (CFC-12) discovered in sea freight concealed inside 72 metal cans containing antifreeze (Japan, Port of Tokyo).

Source: Asia/Pacific Regional Intelligence Liaison Office (WCO RILO)

Implementation of international regulations such as those relating to the environment requires awareness raising and the training of customs staff and other law enforcement services.

One of the WCO's key missions is training and technical assistance, which are the cornerstone of any modernization and capacity building process.

The WCO secretariat currently has five regional training centres (Azerbaijan, Hungary, Lebanon, Russian Federation and South Africa). Other training centres will shortly be available to the WCO for organizing training activities for customs officers at national or regional level. These centres are also available to the WCO's partners when training is to be given to customs services or for awareness raising of customs partners about WCO missions and activities.

The WCO e-learning programme has two inseparable components: an on-line training management platform, and interactive multimedia training modules. There is individual monitoring of training using tutorship tools and a network of experts. The system was launched in June 2003 with a course on customs controls, intended for customs administrations only. A module on determining the customs value of goods will be launched at the end of June 2004. In 2005 there will be a course on the Harmonized System (GHS) and another on customs and CITES.

1. In 1994 the Customs Co-operation Council adopted the working name World Customs Organization. The Convention establishing a Customs Co-operation Council was signed in Brussels in 1950. The CCC's inaugural session was held on 26 January 1953 in the presence of 17 founding Members. The WCO's Headquarters are located at 30 Rue du Marché, Brussels B-1210, Belgium.

☞ *continued from page 59*

Training tools

For videos, manuals and other materials that can assist customs officers in identifying and preventing illegal ODS shipments, see www.uneptie.org/ozonaction/library/training.

Integrated training workshops

Pilot workshops for customs trainers and national stakeholders were conducted in New Delhi, India, in November 2001 and in Manila, the Philippines, in February 2003. Other workshops organized by all the partners have introduced (and to a certain extent trailed) the Green Customs concept. The Secretariat of the Basel Convention, CITES, OzonAction, Interpol and the WCO have organized three regional training seminars for port enforcement officers (customs, police, coast guards, prosecutors, environmental officers).

Green Customs can serve integrated chemical management

As a result of these preliminary actions, the Green Customs concept has been introduced to many stakeholders in different international environmental forums, where it has generated very strong interest and support. The well-received pilot training activities demonstrate that this approach is effective. The next step will be to secure funding for full-scale integrated training.

To formalize the agreement to cooperate in this area, institutional arrangements need to be finalized between some of the partners. Other international organizations and secretariats have also shown an interest in becoming partners. This approach will be particularly relevant to "chemical cluster" Conventions that have recently come into force. It is anticipated that training of customs officers will be an important element of national implementation of other MEAs, including the Rotterdam and Stockholm Conventions.

For more information, visit the Green Customs (www.uneptie.org/ozonaction/customs) and WCO (www.wcoomd.org) web sites.

UNEP encourages public-private partnership to respond to illegal ODS trade in ODS

Illegal trade in ODS, principally CFCs, has emerged as a significant global problem in the past few years, especially in Asia. While much equipment that is reliant on CFCs still exists in the region, countries have committed to reduce consumption and production of these chemicals in line with the Montreal Protocol's phase-out schedule. An increase in CFCs smuggling has hampered the take-up of alternative chemicals.

In February of this year, OzonAction's Compliance Assistance Programme (CAP) in the Regional Office for Asia and Pacific organized a Workshop on "Preventing Illegal Trade: Public Private Partnership" in Hua Hin, Thailand. It brought together, for the first time to combat illegal ODS trade, representatives of industry and government from China, India, the European Union and Russia (which now no longer produces CFCs), as well as representatives of the World Bank and two NGOs, the Environmental Investigation Agency and the Stockholm Environment Institute.

The two-day meeting considered problems caused in Asia by the burgeoning illegal trade in ODS. Participants, representing 85% of total global CFC production, committed themselves to greater cooperation and transparency in sharing information and intelligence to combat this problem.

The meeting (part of UNEP's activities to implement the Montreal Protocol under the Multilateral Fund) recommended a system of informal information exchange between countries, specific actions on tackling illegal trade, and follow-up bilateral and regional initiatives.

and cleaning of the plastic, results in direct damage to human skin. Most of the migrant workers who cook circuit boards suffer from headaches and vertigo. Moreover, there are many cases of bladder stones, chronic gastritis, and gastric and duodenal ulcers that need further investigation with respect to links with the health effects of e-waste.

The discovery of widespread informal recycling activities raises fears that China's electronic waste smuggling problem extends far beyond Guiyu. In the latest findings released by BAN and Greenpeace in April 2004, electronic waste was mixed into steel and copper scrap being unloaded 24 hours a day in the port of Taizhou, Jiejiang Province, from vessels arriving from Korea and Japan. Hundreds and perhaps thousands of farmers are now engaged in primitive and highly polluting electronic waste recycling operations, which involve open cooking of circuit boards, shredding, and primitive smelting. These small-scale operators are very easy to locate due to the acrid smell of melting solder. Farmers claim they will starve if they are only able to farm. They desperately cling to additional income from circuit board cooking, melting and chip-pulling.

Guiyu and Taizhou, the largest and most concentrated sites of electronic waste trade in China, are faced with environmental pollution, health hazards, unfair trade, and other related problems. The hidden, interrelated issues of environmental and social justice (including labour rights, unfair trade and corporate liability) need to be addressed. Links between electronic waste in Guiyu and the US and Japan involve not only a general environmental issue, but also global trade issues including trade ethics.

The way forward

Regarding hazardous waste, much needs to change on the international scene. Authorities give too little attention to reducing/eliminating hazardous waste at source.

The Basel Ban was justified by the Parties to the Basel Convention on the basis that transboundary movements of hazardous waste from OECD to non-OECD countries were unlikely to constitute environmentally sound management of hazardous waste, as required by the Convention. This conclusion was based not only on the obvious lack of technical capacity in developing countries, but also (more importantly) on the fact that exporting pollution to avoid higher costs always works against the primary goals of the Basel Convention. These goals are:

1. minimization of hazardous waste generation;
2. national self-sufficiency in hazardous waste management;
3. minimization of transboundary movements of hazardous waste.

Although these primary goals were supported and furthered by the hazardous waste trade ban (Basil Ban) and the 1993 global ban on ocean dumping of low-level radioactive waste, much more can and needs to be done to reduce/eliminate the generation of hazardous materials and products. Clear targets and timetables, and producer responsibility, are essential.

Dismantling imported e-waste

Far more resources and efforts will be required. However, hazardous waste recycling is part of the problem when substitute materials or technologies exist that could avoid hazardous waste generation in the first place. Hazardous waste recycling can indeed be a serious problem, in that it creates/expands market demand for continuing hazardous waste generation.

The United States, the world's largest hazardous waste generator, could reduce its hazardous waste generation by over 41% over less than five years through substitution without negative macro-economic implications.[9] Yet if there is no "driving force" such as mandatory substitution, hazardous waste generation will continue to increase over time.

The solution to traditional problems of hazardous waste is clear and available, but politics and short-term special industry interests obstruct countries' efforts. The developed countries with the greatest capacity need to lead the way by reducing their ever-increasing hazardous waste generation through mandatory substitution. This is especially necessary now if we are to achieve sustainable development, production and consumption patterns as new issues continue to emerge.

Interview with a worker in a shipbreaking yard, Bangladesh

As an agrarian society, Bangladesh is not used to hazardous work like the breaking of ships. Our country and the people are not ready to deal with the hazards. The only work hazard our country has always had is that you might cut your finger if you were digging the field. Workers at the shipbreaking yards think it is common that if you cut a ship it might blast and you die. Sometimes now we observe that if a ship is gas free, it is safer to cut the ship. However, it regularly happens that blasts take place and that bodies are thrown from the ships and people lose their legs or hands. We do not know how many people die from blasts in the shipbreaking yards. It is heard that almost every day a labourer dies. It is natural; it belongs to the job. It is not new that a labourer dies. The workers have adapted it as their normal lifestyle.

Notes

1. There were 118 signatory countries. The Basel Convention Secretariat site is www.basel.int.
2. Most OECD members are also EU Member States and are therefore subject to EU regulations. For OECD activities in the area of hazardous waste management, see www.oecd.org.
3. For the Basel Ban, see www.ban.org.
4. See www.imo.org/environment/mainframe.asp?topic_idi818.
5. See www.basel.int/ships/index.html.
6. Greenpeace has found that most end-of-life vessels fly "flags of convenience" provided by such countries when they make their final voyage to shipbreaking yards.
7. Million light displacement tonnage per year.
8. Prepared by the Basel Action Network (BAN) and the Silicon Valley Toxics Coalition (SVTC), with contributions by Toxics Link India, SCOPE (Pakistan) and Greenpeace China, February 2002. The entire report can be downloaded at www.svtc. org/cleancc/pubs/technotrash.pdf.
9. United States Congressional Office of Technology Assessment (OTA), report on waste management, 1987. ◆

Safer road transportation of hazardous material in India: TransAPELL in practice

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Summary
In India, with its vast geographical area, large consumer market and extensive chemicals industry, safety is of the greatest concern to industry and the government. Since its first Awareness and Preparedness for Emergencies at Local Level (APELL) programme was launched in 1992, India has taken great strides towards making the transportation and handling of hazardous material safer. This article highlights activities and projects carried out to address the most pressing safety issues in this area.

Résumé
Compte tenu de l'immensité du territoire, de l'ampleur du marché grand public et de l'importance de l'industrie chimique, la sécurité est en Inde l'une des préoccupations majeures de l'industrie et du gouvernement. Depuis le lancement en 1992 du premier programme de sensibilisation et de prévention des accidents industriels à l'échelle locale (APELL), l'Inde a fait d'énormes progrès dans le domaine de la sûreté du transport et de la manipulation des matières dangereuses. L'article présente les activités et les projets mis en œuvre pour s'attaquer aux problèmes de sûreté, particulièrement pressants dans ce domaine.

Resumen
Debido a la enorme extensión geográfica, el importante número de consumidores y la gran industria química de la India, la seguridad constituye una de las principales preocupaciones del gobierno y los industriales del país. Desde el lanzamiento del Programa de Concienciación para Emergencias a Nivel Local (APELL) en el año 1992, la India ha tomado medidas de gran envergadura para contar con más seguridad en el transporte y el manejo de materiales peligrosos. Este artículo destaca las actividades y proyectos realizados con el objetivo de atender los temas de seguridad más apremiantes en dicho sector.

UNEP's APELL programme is designed to:
- create or increase public awareness of possible hazards within a community;
- stimulate the development of cooperative plans to respond to any emergency that might occur;
- encourage accident prevention.[1]

When the National Safety Council of India (NSCI) agreed to host an APELL programme in 1992, one of the main considerations was the situation prevailing in the aftermath of the 1984 Bhopal disaster. Bhopal was followed by a number of incidents across India involving hazardous materials. NSCI was well-suited for this responsibility, in view of its 38 years of experience promoting voluntary health, safety and environmental activities with a range of services, and its all-India network of 6000 members, 28 Action Centres and 14 Chapters.

Considering India's vast size, a strategy with a two-track approach was conceived at the outset. This approach comprised:
- development of awareness at the national level;
- need-based, in-depth implementation of APELL activities at selected high-risk industrial areas in different regions.

Transport of hazardous materials and TransAPELL

As a result of seminars and workshops organized for six high-risk industrial areas,[2] it was recognized that attention needed to be focused on the transportation of hazardous material (Trans-Hazmat). India's first TransAPELL workshop was held in June 2000, in collaboration with UNEP and the Bharat Petroleum Corporation (BPC), a Fortune 500 company. The workshop was inaugurated by the Maharashtra State Crisis Group Chairman.

Twelve unanimous recommendations by the TransAPELL workshop were accepted by the State Crisis Group. Four of these recommendations established priorities:
- NSCI should play a key role in Trans-Hazmat, as a catalyst and coordinator at the national level;
- A demonstration project should be undertaken in the Chembur-Trombay area of Mumbai, with international support;
- A training module on Trans-Hazmat should be developed for highway traffic police, and training should be carried out;
- A suitable community awareness strategy should be developed.

In 2002 a project on "Development and Operation of the National APELL Centre (NAC)" was begun. It provided an opportunity to implement the recommendations of the TransAPELL workshop, addressing the key issues of strengthening off-site emergency preparedness and developing capabilities and a network to meet long-term APELL objectives.

The Road Transport Safety Initiative

Realizing that Trans-Hazmat cannot be effectively addressed without also addressing some basic road transport safety issues, NSCI launched a Road Transport Safety (RTS) Initiative targeting all industrial goods, hazardous and non-hazardous. A majority of large companies that generate high goods traffic moved by transporters are NSCI members. NSCI it is well-placed to influence transporters in collaboration with these companies.

Such a programme, with its wide scope and socio-economic implications, requires sustained inputs. These inputs have been successfully mobilized by UNEP, USAID/WEC (World Environment Center) and NSCI, which collaborated in the project.

A three-member Project Team led by the author (as Project Director), with secretarial support, has been provided by NSCI since the project's beginning. Each of the six high-risk industrial areas furnished a coordinator during the first phase. NSCI Chapters, Factory Inspectorates and Major Accident Hazard (MAH) units[4] also furnished in-kind facilities in the local areas

In the first phase, the services of 25 international and 74 national resource persons were used. In addition, eight technical persons were sent to the United States for study tours/training. Sixty-eight technical publications, 14 videos and copies of CAMEO (Computer-Aided Management of Emergency Operations) software were received for capacity building. Many technical experts have been involved in the project's two other phases.

All expenses for international inputs were directly paid by USAID, which also reimbursed US$ 86,000 in expenses incurred in India during the first phase. UNEP met the expenses of the experts it had provided. NSCI paid the salaries of the Project Team. It also mobilized the ex-gratia services of local coordinators and national resource persons, as well as funding of about US$ 15,000. There was nominal funding of US$ 15,000 from UNEP for the NAC. NSCI is managing the project using its own resources.

Achievements of the Road Transport Safety Initiative

Workshops, seminars and training courses were organized at the national and local levels. The following achievements were crucial in laying the foundation for further work:

Awareness

The APELL Process was previously unknown. Its usefulness is now well-appreciated.

Crisis Groups

Crisis Groups on the APELL model have been set up at the national, state, district and local levels.[3] This is a major achievement. These groups are legally responsible for strengthening Hazmat Emergency Preparedness and Community Awareness in cooperation with MAH units, authorities, public response services and the community.

Testing of emergency plans

A clearer understanding and competence have been developed with respect to the system for testing emergency plans, the stages involved and tools used. Table-top exercises have been particularly useful.

Capacity building

NSCI capabilities have been strengthened in areas including risk assessment; emergency plan development, review and testing; and use of CAMEO software. These capabilities are being used for sustained APELL activities.

Issues identified

The following issues have been identified:

- Trans-Hazmat;
- community awareness;
- development of integrated off-site emergency plans;
- strengthening the capabilities of public emergency response services;
- development of a Hazmat Emergency Medical Response System.

Demonstration project: cooperation between NSCI and other key players at Chembour-Trombay

The Chembur-Trombay area of northeast Greater Mumbai is spread over 10 square kilometers. It has a large population and overcrowded roads. Close to the Eastern Express railway and the Mumbai-Pune-Bangalore highways, it is bounded by the port of Mumbai. There is a cluster of industrial units, including two oil refineries, a fertilizer complex, a nuclear complex, a power station, and chemical and petrochemical complexes.

In addition to rail transportation, an average of 300 tank lorries per day carry oil products by road. A total of 3 million metric tonnes of these products per month is moved by rail and road. Large volumes of Hazmat products from other industrial units are also moved.

NSCI worked closely with leading industries in the area through the Mutual Aid and Response Group (MARG), the District/Local Crisis Group, the Directorate of Industrial Safety and Health (the enforcement authority for Maharashtra), the Chembur Fire Brigade and leading industrial units. Our collaborator, the BPC, has a refinery in the area. A UNEP expert participated in some meetings with key players.

The MARG formed by the area's leading industrial units to share their resources has regular interactions with the Mumbai Fire Brigade, the police, civil defence and municipal authorities, and other MARGs of Greater Mumbai.

The following achievements are due to the combined efforts of NSCI and other key players:

1. An off-site emergency plan for the area, developed according to statutory requirements, was promulgated in 2003;
2. A special hospital with a burn care ward was recently set up in the area with the support of MARG members. It is open to general public;
3. BPC and HPC have reduced Trans-Hazmat by road by installing pipelines. BPC's Mumbai-Manmad pipeline transports 40% of its products. HPC's Pune, Santacruz and Wadala pipelines transport 70% of its products;
4. The railway and the Bombay Municipal Corporation have developed a well-defined pay-and-park area for overnight parking of tank lorries. Traffic congestion due to irregular parking of tank lorries was a serious hazard for years. The problem defied solution in the absence of determined, coordinated action;
5. Emergency escape routes have recently been identified and ways to activate them have been formulated;
6. To ease traffic congestion, State transport authorities have placed restrictions on movements of containers during peak hours;
7. A MARG website (www.aegisindia.com/safety) has been launched and is accessible by the public;
8. To meet the shortage of trained Hazmat drivers, approved training centres have been set up by BPC, HPC and others to facilitate three-day training.[5] This training is provided at low cost at convenient times;
9. Hazmat training programmes for traffic police and awareness seminars for the community are conducted regularly.

Case study: Trans-Hazmat response at Mumbai

A recent case study gives an idea of Trans-Hazmat emergency preparedness in this area.

At 11.30 pm on 27 January 2004, a tank lorry carrying 20 tonnes of benzene loaded at the BPC refinery overturned at a traffic signal in Sion, a suburb of Mumbai about 20 kilometres from the refinery. The benzene started to leak and the lorry caught fire.[6]

The response by traffic police and the Mumbai Fire Brigade was prompt and effective. Occupants of nearby buildings affected by the intense heat were evacuated without panic or injuries. Only the driver, who jumped out, was injured. At 3.30 a.m. the Mumbai Fire Brigade asked the refinery to supply foam for use in fire-fighting. This request was met without delay. The product was allowed to burn under controlled conditions. The fire was extinguished by 11.30 a.m. and the burned lorry was towed to nearby open ground.

The handling of this incident received prominent and positive media coverage.

Case study: experience with a Hazmat van at Patalganga-Rasayani

One of our objectives is to study and promote a proven arrangement/approach. Accordingly, we identified and analyzed a successful Trans-Hazmat emergency response experience in the Patalganga-Rasayani Industrial Area. Subsequently we published a case study and recommended that this approach be used at the national level.

This area is about 40 kilometres from Mumbai. It is located between two national highways. There is a cluster of hazardous units. In August 1996 these units jointly established an Emergency Response Centre with a well-equipped Hazmat van. As of December 2003, the van had successfully responded to 84 Trans-Hazmat calls involving 27 different chemicals. Based on an analysis of this experience, 15 observations/recommendations have been made. The most important are:

- The product transported by many Hazmat tank lorries frequently changes. However, the required EIP (Emergency Information Panel) is not changed, as it is permanently painted on. The use of suitable stickers has been recommended.
- Many Hazmat drivers carry a set of Tremcards (Transport Emergency Cards) for all the products transported at different times. Drivers should carry only one Tremcard, for the specific product being transported.

Experience shows that initial information given to the Hazmat van by traffic police can be incomplete and sometimes misleading. The number of traffic police personnel is large. They are often transferred. Their proper training in communicating an incident information summary remains an issue.

It is heartening that about two years ago the oil companies jointly established Trans-Hazmat vans at about ten strategic locations across India.

Other important achievements

Commitment by transporters

To build on the achievements of the Chembur-Trombay demonstration project and experience at Patalganga-Rasayani, seminars developed under our RTS Initiative were held in these two areas in May 2004. BPC continued to be our collaborator at Chembur-Trombay. Reliance Industries Ltd. (also a Fortune 500 company) was enlisted as our collaborator at Patalganga-Rasayani.

As an outcome, 47 transporters from Chembur-Trombay and 66 from Patalganga-Rasayani issued press releases expressing their commitment to improve road safety. Future action points were also identified.[7]

Training of traffic police

A one-day training module has been developed. All senior officers of the Maharashtra Highway Traffic Police have been trained. About 200 traffic police constables have also been trained. While MARGs regularly conduct such training, there is a need to institutionalize it in police training institutes.

Community awareness
A strategy has been developed and published. Programmes are being carried out by MARGs.

Current comprehensive activities
Two comprehensive activities are being implemented to develop off-site emergency plans, provide training to Local Crisis Groups, enforcement officials and MAH units, and give guidance on testing of plans.

It is also planned to establish an APELL Sub-Centre in Tuticorin. The Trans-Hazmat experiences will be implemented in two districts: one in Tuticorin, south India, and the other in Haldia, West Bengal

The NAC newsletter, specific case studies, information sheets and our regular periodicals are being used to propagate lessons learned at the national level.[8] These lessons will also be discussed at our National Conference in 2005 in New Delhi.

Notes
1. For UNEP's APELL programme (including TransAPELL), see www.uneptie.org/pc/apell.
2. The Manali-Ennore Industrial Area near Chennai, southern India; the Thane-Belapur Industrial Area near Mumbai, western India; Cochin, southern India; Kanpur, northern India; Haldia, eastern India; Vadodara, western India.
3. Under India's Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, notified in 1996 under the Environment (Protection) Act, 1986.
4. MAHs are statutorily identified.
5. Under the Central Motor Vehicle Rules, 1989.
6. Benzene is a clear, colourless liquid used in production of plastics, paints, rubber and resins. It is highly flammable. Inhaling benzene can also have harmful health effects.
7. Their combined fleet strength was 2000 and 3000 vehicles, respectively.
8. Publications developed, published and disseminated at the national level include: a list of approved Hazmat Driver Training Centres under the CMV Rules, 1989 (copies available from different States); NAC newsletter, begun in June 2002 (two issues have been published and 7000 copies have been mailed to key APELL Partners, including members of Crisis Groups and NSCI members); information sheet giving a résumé of important statutory provisions on Trans-Hazmat under different legislation, based on feedback from the traffic police officers' workshop; case study on the Hazmat emergency response van, based on successful experience in the Patalganga-Rasayani area. ◆

Transparency and communities' right-to-know: working towards better disaster management through the OECD

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Summary

Governments and industry are increasingly making efforts to share information on chemical safety. There are many national and international legal tools to ensure communities' right-to-know. In this regard, the OECD has developed guidance and adopted a number of Decisions and Recommendations related to chemical safety. Communication with the public is a joint responsibility of government, industry and the community, and public-private partnership is essential. Society generally benefits when information about the risks of chemical operations is shared broadly. Nevertheless, there is concern that making certain types of information publicly available could endanger security.

Résumé

Les gouvernements et l'industrie font de plus en plus d'efforts pour échanger l'information sur la sécurité chimique. Il existe de nombreux instruments juridiques nationaux et internationaux pour garantir aux citoyens le droit de savoir. De son côté, l'OCDE a émis des avis et a adopté un certain nombre de décisions et recommandations relatives à la sécurité chimique. La communication avec le public est la responsabilité conjointe du gouvernement, de l'industrie et des citoyens et la coopération entre secteur public et secteur privé est, à cet égard, essentielle. La société a généralement tout à gagner à échanger le plus largement possible l'information sur les risques liés aux activités impliquant des produits chimiques. Le risque que la communication au public de certaines informations mette en péril la sécurité suscite cependant certaines inquiétudes.

Resumen

Los sectores gubernamentales e industriales dedican cada vez más esfuerzos al intercambio de información sobre seguridad en la gestión de sustancias químicas. Existen múltiples herramientas legales nacionales e internacionales para proteger el derecho de las comunidades a estar informadas. En este sentido, la OCDE ha publicado directrices y ha adoptado una serie de Decisiones y Recomendaciones vinculadas a la seguridad en la gestión de sustancias químicas. La comunicación con el público en general es responsabilidad conjunta de los gobiernos, las industrias y las comunidades, y el establecimiento de alianzas entre el sector público y el sector privado desempeña un papel crucial. Por regla general, la sociedad se beneficia cuando se difunde ampliamente la información acerca de los riesgos que implica la gestión de sustancias químicas. No obstante, existe el temor de que difundir cierto tipo de información podría poner en riesgo la seguridad.

Members of the public who might be affected in the event of an accident at a hazardous installation have a right to the appropriate information, so that they will be aware of the hazards and risks arising from such installations in their community, and so that they can act appropriately should an accident occur. Communication with the public is a joint responsibility of government, industry and the community. Communication channels need to be two-way. Members of the community should participate in the development and implementation of communication programmes.

Governments and industry are increasingly making efforts to share with the public information on chemical safety, including preparedness and response. One of the main topics concerns the possible effects of chemical releases caused accidentally. Governments and industry also agree that decisions on the management of related risks should be made transparent to the public.

Community right-to-know: a legal requirement

There are a number of national and international legal tools to ensure the community's right-to-know. Examples are:

- The *EC "Seveso II" Directive* on the control of major-accident hazards involving dangerous substances includes Article 13, on information on safety measures and availability of safety reports to the public;
- The UNECE *"Aarhus" Convention* is built on three pillars: access to information (article 4-5), public participation in decision-making (article 6-8) and access to justice in environmental matters (article 9);
- The *United States Environmental Protection Agency's Risk Management Programme (RMP)* includes a part on public availability of information;
- Through the *Responsible Care Programme* (developed and adopted by chemical industry associations), companies agree to report their goals and progress to the public;
- The *OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response* includes a chapter on communication with the public.

Sharing information: communication with the public

The OECD Chemical Accidents Programme works on developing guidance on prevention of, preparedness for and response to chemical accidents, and on facilitating sharing of information and experience among both OECD and non-OECD countries. This work is carried out in cooperation with other international organizations, including UNEP, the UN Economic Commission for Europe (UNECE) and the UN Office for the Coordination of Humanitarian Affairs (UNOCHA). Its major products include: the *Guiding Principles for Chemical Accident Prevention, Preparedness and Response* (which consists of guidance for public authorities, industry and communities); the *Guidance on Safety Performance Indicator* (SPI) to help those stakeholders develop safety programmes; and the *Chemical Accident Risk Assessment Thesaurus* (CARAT), a data base containing analyses of laws, regulations, policies, definitions and case studies. All these tools are easily accessible on the internet (see References below).

The OECD has also adopted a number of Council Acts related to chemical safety. Two of them are relevant to information exchange:

- The Decision on the *Exchange of Information concerning Accidents Capable of Causing Transfrontier Damage* requires that member countries exchange information and consult one another, with the objective of preventing accidents capable of causing transfrontier damage and reducing damage should an accident occur. Member coun-

tries shall also take all necessary practical steps to implement the provisions relating to the exchange of information (e.g. information on hazardous installations, the organization of emergency measures, transmission of emergency warnings and confidentiality).

- The Decision-Recommendation concerning *Provision of Information to the Public and Public Participation in Decision-Making Processes related to the Prevention of, and Response to, Accidents involving Hazardous Substances* requires member countries to ensure that the potentially affected public is provided with both specific information on the safety measures they should adopt in the event of an accident (and general information on the potential effects of possible major accidents on human health and the environment) and that it has access to information needed to understand the effects of an accident. This Council Act also recommends that member countries take action to facilitate opportunities for the public to comment prior to decisions being made by authorities concerning hazardous installations (siting, licensing, etc.).

The *OECD Guiding Principles* mentions that communication channels need to be two-way, and that members of the community should participate in the development and implementation of communication programmes. Information provided to the potentially affected public should include specific guidance on what to expect in the event of an accident, including:

- details about how the potentially affected public will be warned of an accident or the imminent threat of an accident;
- guidance for the potentially affected public concerning the actions to be taken and behaviour to be adopted in the event of an accident;
- an explanation of why the public should behave/act as described in the guidance, so that it understands how this will result in a mitigation of adverse effects;
- source(s) of post-accident information (e.g. radio or television frequencies);
- source(s) of additional explanations/information;
- point(s) of contact, where members of the public can provide public authorities with information related to a possible accident;
- how members of the public will be informed when the emergency situation is over.

According to the Guiding Principles, the potentially affected public should also be provided with additional information about the hazardous installations in their vicinity without having specifically to request it. This information should address:

- types of industries in the area and the chemicals produced and used in these installations;
- name(s) of the enterprise(s) responsible for installation(s) and address(es) of the installation(s);
- information relating to the types of possible accidents that could cause serious off-site damage, and their potential effects on health, the environment and property;
- preventive measures that have been taken to minimize the likelihood of accidents;
- a reference to the off-site emergency plan;
- point(s) of contact, where further explanatory information and clarification can be obtained and feedback can be provided to rescue services and other authorities;
- information concerning expected activities at the installation that may cause concern among neighbours.

To avoid confusion and facilitate information exchange, the mechanisms for obtaining and delivering information should be as clear as possible and should use, to the extent possible, known and existing channels.

The *OECD Guidance on SPI* serves as a guide to help industry, authorities and communities measure the extent to which actions help improve chemical safety. It provides a systemic approach to measuring the success of stakeholders' chemical safety programmes by detailing targets, activity indicators and outcome indicators. There is flexibility for groups to design programmes to assess their own performance related to prevention of, preparedness for and response to chemical accidents.

The SPI Guidance also addresses cooperation among industry, public authorities and the public:

- For industry, the target is to help ensure effective cooperation with the public and other representatives of the community (e.g. hospitals, schools, nursing homes, environmental groups, media and academia);
- For public authorities, the target is to establish a two-way system of communication with the public, providing an opportunity for public input to the authorities (as well as providing information to the public from authorities); such communication will allow the two parties to learn from each other.

The responsibility of members of the community is twofold: information acquisition, and communication of the information acquired to the potentially affected public. For communities, the target is that the potentially affected public understands what actions to take in the event of an accident involving hazardous substances.

Public availability and use of information

The public will make use of information to the extent that the information is understandable, useful and easy to use. The more effort required, the less likely the public is to seek out the data. The data base of a public interest group on the internet is viewed far more than an onsite inventory with data from industry, which usually requires more effort in order to find information that is useful and understandable by the public.

Considerable information relevant to emergency preparedness and response can also be obtained from scientific data bases, web sites of relevant institutions (including companies), articles, publications, simple calculation tools available in scientific literature, transport labelling on materials, simple maps and aerial photographs. However, such information is not provided in an "organized" manner, which would mean it could easily be used by the community to promote safety. It is essential that information be structured and possibly explained, available in both "passive" and "active" forms, communicated effectively to the potentially affected public, and translated into facts and figures that can enhance public understanding (and therefore its participation in decision-making).

Public-private partnerships for better safety

Partnerships among governments, non-governmental organizations and the chemical industry are essential for enhancing environmental safety and improving the capacity to mitigate the consequences of chemical releases. The public's right-to-know and the dissemination of information relevant to chemical safety are important components of public-private partnerships.

Enterprises conducting chemical operations should establish effective communication channels with relevant public authorities at all levels of government, including those responsible for emergency preparedness and response, domestic security, and public health and safety. Chemical safety is not restricted to the production site. It necessarily extends to the management of chemicals from the supply chain to the environmentally sound disposal of hazardous wastes.

Community right-to-know vs. information security

Making information about risks in the community available can help the public understand how to react appropriately should there be a release of hazardous chemicals. However, there is concern that providing information to the public can also give prospective terrorists information they could use to plan or carry out terrorist acts on chemical facilities.

As a general rule, society benefits when information about the risks posed by chemical operations is shared broadly. Some security related information may increase risks if released broadly. The fundamental question is whether a particular form of disclosure of a particular kind of information about some chemical operations would, overall, reduce or increase the risk posed by those operations. Authorities should establish processes for making such determinations, whether generically or in single cases. In some cases, assessments of this type of risk lead to the conclusion that internet access to risk management programmes would increase the possibility of a chemical release caused by terrorists or other criminals. The terrorist acts of 11 September 2001 have refocused thinking about the balance between terrorism concerns and public access; as a result, authorities in some countries have removed certain information on the safety in factories from their website.

The processes of determining the balance between public access and terrorism concern should weigh the expected gain in safety against expected losses, such as limitation of democratic rights or the loss of safety and transparency gained by risk communication. The 1993 OECD Workshop on

Communication related to Chemical Releases Caused by Deliberate Acts (co-sponsored by several international organizations) allowed experts from OECD and non-member countries to exchange information, experience and solutions regarding policies, safety programmes and tools[1] in connection with risk communication and public information.

The workshop also explored the potential conflict between maintaining transparency and the risks that result from doing so. It discussed the elements of risk communication that are different in the context of terrorist acts, as compared with risk communication related to chemical safety in general. The workshop came up with a number of conclusions and observations concerning how countries should deal with risk communication and public information in regard to chemical safety. One is that governments should increasingly share chemical safety information among different governmental levels and agencies and among countries.[2]

The opinions expressed in this article do not necessarily represent those of the OECD or its member countries.

References (available at www.oecd.org/env/accidents)

OECD Council Acts:

- Decision of the Council on the Exchange of Information concerning Accidents Capable of Causing Transfrontier Damage [C(88)84].
- OECD Decision-Recommendation concerning Provision of Information to the Public and Public Participation in Decision-Making Processes related to the Prevention of, and Response to, Accidents involving Hazardous Substances [C(88)85].

OECD publications:

- *OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response*, second edition. Environment, Health and Safety Publications, Series on Chemical Accidents, No. 10, 2003.
- *OECD Guidance on Safety Performance Indicators*. Environment, Health and Safety Publications, Series on Chemical Accidents, No. 11, 2003.
- *OECD Chemical Accident Risk Assessment Thesaurus (CARAT)* (internet data base, www.oecd.org/ehs/carat; also accessible at www.oecd.org/env/accidents).
- *Report of the OECD Workshop on Communication related to Chemical Releases Caused by Deliberate Acts (25-27 June 2003, Rome, Italy)*. Environment, Health and Safety Publications, Series on Chemical Accidents, No. 12, 2004.

Notes

1. Examples include the Risk Management Programme in the United States, the ongoing Dutch experience with its register of risk situations involving hazardous substances, and the recommendations of the German Hazardous Incidents Commission (www.sfk-taa.de/Berichte_reports/Other_languages/sfk-gs-38_engl.pdf).
2. For details, see the report of the workshop (www. oecd.org/env/accidents).

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Financial sustainability at a National Cleaner Production Centre: the experience of the Honduras NCPC

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Summary
The National Cleaner Production Centre in Honduras was launched in 2000, with funding from the Canadian International Development Agency for its first five years of operation. CIDA also funded the feasibility study and project design for the Centre in 1998. The implementation strategy developed by consultants identified financial sustainability as a major objective. Detailed mechanisms for cost-recovery were recommended, as well as several cost-sharing arrangements for delivery of the Centre's services. Surplus funds would accrue to a Sustainability Fund. Significant progress appears to have been made in this direction. By 2003 this fund had grown to the extent that CIDA's contribution constituted only 50% of the Centre's operating budget; the rest came from participating industries. This article describes the basic elements of the strategy pursued, challenges, progress, and lessons learned by the Centre in its efforts to achieve financial sustainability.

Résumé
Le Centre national de production plus propre du Honduras a été ouvert en 2000 avec l'aide financière de l'Agence canadienne de développement international (ACDI) pour les cinq premières années de fonctionnement. L'ACDI avait également financé in 1998 l'étude de faisabilité et de conception du Centre. La stratégie de mise en œuvre développée par les consultants avait placé la viabilité financière parmi les principaux objectifs du projet. Des mécanismes détaillés d'amortissement des coûts avaient été recommandés, ainsi que plusieurs systèmes de partage des coûts pour les prestations assurées par le Centre, les excédents de trésorerie devant être affectés à un fonds de viabilité. D'importants progrès semblent avoir été faits dans ce sens. En 2003, le fonds avait atteint un niveau tel que la contribution de l'ACDI ne représentait plus que 50 % du budget de fonctionnement du Centre, le reste provenant des industries participantes. L'article décrit les composantes essentielles de la stratégie élaborée, les obstacles, les progrès et les leçons tirées des efforts du Centre pour parvenir à la viabilité financière.

Resumen
El Centro Nacional de Producción Más Limpia de Honduras fue creado en el 2000 con fondos de la Agencia Canadiense para el Desarrollo Internacional para su funcionamiento durante los primeros 5 años (habría que mencionar aquí lo del Fondo Medio Ambiente Honduras-Canadá). ACDI financió también el estudio de factibilidad y proyecto de diseño del Centro en 1998. La estrategia de implementación desarrollada por los consultores planteaba la sostenibilidad económica como objetivo primario. Ellos recomendaron varios mecanismos para la recuperación de costos, así como para compartir los mismos, al momento de ofrecer servicios. Las ganancias del Centro serían asignados a un Fondo de Sostenibilidad. En este sentido han habidos avances significativos desde la creación del Centro. Para el año 2003 los ingresos del Centro han crecido de tal manera la contribución de ACDI, constituye solo el 50% del presupuesto anual, el resto proviene de clientes que contratan los servicios del Centro. En este documento se describen los elementos básicos de la estrategia llevada por el Centro Nacional de Producción Más Limpia de Honduras, los retos encontrados, sus logros y las lecciones aprendidas, en su esfuerzo por alcanzar la sostenibilidad.

In May 1998, the National Cleaner Production Centre in Honduras (Centro Nacional de Producción más Limpia Hondureñ, or CNP+L-H) was created by a resolution of the second General Assembly of the Honduran Business Council for Sustainable Development (Consejo Empresarial Hondureño para el Desarollo Sostenible, or CEHDES). In August of that year the Honduras-Canada Environmental Management Fund of the Canadian International Development Agency (CIDA) funded a feasibility study and project design for the Centre. The feasibility study indicated broad industry interest in, and support for, CP objectives. Indeed, the consultants involved cited UNIDO as reporting that "industry support in terms of in-kind contribution for the proposed Centre significantly exceeds that for any of the four national centres for cleaner production already established in Central America."

In 2000, CIDA committed funds for the Centre's first five years of operation. CNP+L- Honduras thus became the region's youngest cleaner production centre. In September 2000, with most of the Centre's staff in place, the 1998 implementation strategy was revisited with the staff and its validity was reaffirmed. A bolder and more detailed set of goals was defined, and a detailed work plan for Year 1 was developed with the ultimate purpose of verifying the underlying assumptions of the Centre's design. Activities were officially launched three months later.

Implementation strategy

It was envisaged that the CNP+L-H would engage in activities in four areas: information dissemination, training, in-plant demonstration projects, and policy assessment and advocacy. It was to be administered by three full-time staff members (assistant or technical director, programme officer and office manager). The Executive Director would work on a part-time (40%) basis. A consultant engaged by CIDA to undertake the feasibility study and design applied a SWOT (Strength, Weakness, Opportunity and Threat) analysis to the project objectives, management structure and delivery mechanisms in all four programming areas. Very detailed responses were developed to the perceived weaknesses, opportunities and threats.

One of the Centre's core objectives was to achieve financial sustainability. To meet this objective, a separate implementation strategy was developed. Mechanisms were defined for generating funds through cost-recovery, cost-sharing and income-generating arrangements with respect to delivery of the Centre's services. These funds would accrue to a Sustainability Fund. This was a new fund (a new and separate "account") established within the Centre to identify monies coming to the Centre from cost-recovery and from profit-generating services. The CIDA consultant also recommended that the Centre take part in

promoting and establishing ISO 14001 among Honduran enterprises. Interviews with industry leaders had indicated a far greater interest among Honduran manufacturing businesses in environmental management systems (EMS) than in cleaner production. It was considered important for the Centre to be engaged in work on EMS to win the confidence of industry.

This article describes the challenges encountered, progress made and lessons learned by the National Cleaner Production Centre of Honduras in its efforts to achieve financial sustainability.

Table 1
Some of the Centre's clients and the financial benefits they derived from adopting CP

Company (no. of employees)	Sector	Main recommendations	Market	Benefits
Manufacturas el Trópico (469)	aluminium furniture manufacturing	• change quality control, increase quality assurance • use specialized equipment for angle cuts • prevent contamination of chromium and degreasing solutions • prevent solution loss by insulating surfaces • insulate paint ovens • reduce waste in the weaving process • recycle waste and adequately manage chromium waste	3% domestic, 97% international	166,764.00
PROLACMON (9)	cheese and butter production	• reduce water consumption • reduce milk and curd lost in transport • improve packaging and weighing of final products • standardized milk for cheese at 2%	domestic	71,794.12
El Pataste (14)		• improve formula scaling control • insulate vapour pipes and reduce leaks in all pipes • reduce sticking of *quesillo* to kettle • treat whey as prime material for sub-products rather than waste	domestic	51,901.14
La Josefina (1)	raw coffee processing	• improve classification of the grain • use pulp for fertilization of plantation • reduce water consumption by recycling • construct simple coffee drying facilities instead of using intermediary	domestic	49,157.00
La Campeona (2)				59,177.86
INDEMA (175)	sawmills	• perform preventive maintenance • use every piece of equipment for purpose for which it was originally designed • improve quality control in reception of prime material, process and inventories • improve wood packaging techniques, according to the standards • optimize performance of the curing chamber • reduce dead times • improve boiler efficiency • recycle wood waste for energy generation • recycle metal waste	international	161,796.86
YODECO (184)			32% domestic 68% international	239,258.34

Information dissemination

At first it was difficult to convince Honduran enterprises of the benefits of cleaner production. Case studies from other CP centres were presented, but the general corporate response was that cleaner production would not work in Honduras. To obtain local case studies, the Centre placed special emphasis on information dissemination and marketing at this stage. Short exposure courses were organized for industries. Funding to fund in-plant CP demonstrations was actively sought from other donors. The breakthrough came in 2001 with the sponsorship by USAID PROARCA of a CP demonstration at PROLACMON, a small cheese and butter plant. The Centre used the successful CP demonstration at PROLACMON in its promotion activities and offered several discounts on the cost of on-site CP implementation. Three additional companies came forward to participate.

It was critical to get larger companies to participate. Since PROLACMON was small, many companies believed the CP methodology would only work in small enterprises. Successful CP implementation in the three new companies proved not only that the methodology was feasible in larger enterprises, but that the larger the company, the larger the savings tended to be. Seventeen new clients, paying much more realistic fees, then volunteered to participate. The new clients included large enterprises paying for their own implementation, as well as groups of small ones being financed by donors.

Training courses

It was determined early by the Centre that a principal cause of waste production in Honduran enterprises is substandard production. Quality non-conformance obliges companies to spend extra money (in the form of time, energy, water and raw materials) on reprocessing the product or to lower its price. Waste is also generated by the return and discarding of products on-site. The Centre determined that its courses should focus not only on cleaner production techniques, but also on quality assurance methods.

The Centre has basically been offering two types of courses:

- seminars (a series of introductory lectures on specific themes);
- training courses (generally a combination of lectures and interactive workshops).

Since 2001 the Centre has offered a total of 66 courses, in which 2755 persons have been trained. These courses have been in

- eco-design;
- cleaner production methodology;
- cleaner production for a specific industrial sector;
- ISO 9001/14001;
- the 5 S's (refers to a housekeeping programme);
- energy efficiency;
- climate change;
- environmental assessment;
- cost analysis with environmental criteria;
- pollution prevention in general.

The costs of seminars and training courses are covered by course fees charged directly to the participants, or through sponsorship by a donor or local educational institution. Most courses have local coverage, but the Centre has also offered regional courses.

The non-sponsored courses are of three types: in-plant with implementation (paid for by a company as part of a CP demonstration); in-plant without implementation (offered by a company for its employees but without CP demonstration); open. These courses are delivered by CNP+L-H personnel only, to keep the costs low. The total charged by the Centre for the non-sponsored courses which are not part of in-plant implementation varies from US$ 200 to 5000, depending on the number of participants and course duration. In most cases this covers staff time, travel and course materials.

Of the non-sponsored courses, open ones are the most labour-intensive since they are advertised in the newspapers and require close monitoring to ensure that the desired numbers are reached, and to secure the participants' assistance and payment. The course fees charged participants are set low, mainly to recover the cost of the logistics, but they are calculated such that US$ 1000 per course offering can be applied to the basic cost of the Centre. This strategy has paid off, in that many implementation contracts have resulted from these courses.

The sponsored courses are directed at university students when they are financed by an educational institution, and at environmental consultants and public sector staff when financed by donors. Technical specialists for sponsored courses have come from the Honduran NCPC, other Central American CP centres and the United States Environmental Protection Agency (US EPA).

In-plant CP demonstration projects

The Centre has carried out 21 in-plant CP demonstration projects since January 2001, either completed or in progress in manufacturing facilities of various sizes (from six employees up to more than 2000). Projects completed so far have involved a sugar refinery, an aluminium furniture factory, seven cheese and butter plants, four raw coffee processors and two sawmills. Among those in

progress are two textile and apparel enterprises, two plastic factories, a tannery and a bakery.

The Centre stimulates the interest of these enterprises through courses or interviews. Once interest is expressed, an evaluation and in-house presentation are made to the company staff to explain the cleaner production concept along with its basic methodology, benefits and some success stories. Special emphasis is given to the financial benefits. Examples and success stories are adjusted to the facility's particular situation. The presentation is followed by a question and answer session, after which a budget for the implementation is presented. The budget includes Centre staff time in the office and at the facility, travel expenses and office materials. Since the Centre is partially financed by the Honduras-Canada Environmental Management Fund, a special discount is granted. The charge by the Centre to the individual enterprise for courses as part of CP demonstration is between US$ 7000 and12,000.

Small enterprises are treated differently. Special packages are prepared and presented to donor agencies interested in promoting better environmental performance in specific SME sectors. The package costs around US$ 20,000 per group of four to six enterprises. The cost is high because of travel, and because it may include additional courses for groups in the area (not only the company's personnel).

An in-plant CP demonstration takes approximately eight months. The length of time depends not only on the size, but also on the number of production lines for individual products. In general, a period of eight months would be appropriate for a company with more than five production lines and 20 to 100 employees, or a unique production line but more than 500 employees. A management representative is first designated to serve as the contact person between the Centre and the company. This person also helps coordinate CP team meetings and activities. The CP team includes personnel from sales, procurement, storage, administration, post-sales services, and especially quality control and production. Team members are trained in CP methodology during a 16-hour course. The idea behind this is that the company's personnel should be able to continue implementing CP when the CNP+L-H consultants are no longer there. Any of the trained personnel should be able to introduce the CP concept even if they change jobs.

Once the team is trained, flowcharting of plant processes starts. Every line of production is flowcharted unless otherwise specified in the agreement with the company. These flowcharts are first drawn up in the office with the CP team; they are then revised in the plant during actual operation; finally they are revised again in the office with the team. When the Centre expert is confident that the flowcharts are correct, inputs and outputs are indicated. They are then quantified by the company personnel. The Centre expert provides orientation concerning how and what to measure and how to decide what representative data are. Input and output measurements also include energy and water consumption. Once the measurements are ready, mass and energy balances are performed. Information from the balances, as well as the empirical observations, are used to determine critical points. These critical points may be:

- environmental: sites/stages where waste with a severe impact on the environment is produced;
- economic: sites/stages where waste from expensive products is generated;
- quality: sites/stages where waste due to quality problems is produced;
- process: sites/stages where waste due to process delays is produced.

With the critical points identified and classified, the real causes of the problems are analyzed with the team using mental maps.

Once the real causes of problems are determined, CP recommendations are made and are prioritized by the team using a brainstorming process. In the process of generating recommendations, the Centre always tries to maintain a facilitator's role rather than that of the solution provider. Recommendations are analyzed for their environmental, economic and technical feasibility. Those considered feasible are listed in an implementation chronogram. In the case of recommendations that are not feasible, the team returns to the mental map and takes part in another brainstorming session until it arrives at more feasible ones.

For each recommendation the implementation chronogram shows dates of implementation, allocation of responsibilities and performance indicators, as well as the necessary supporting activities. The indicators selected are easy to measure and quantifiable, in order to be included in a monitoring chronogram. This monitoring or audit process verifies:

- whether the savings projected for implementation of the recommendations are accurate;
- performance of the CP methodology itself, and how well the company's personnel have understood the process.

At this point a CP implementation report is presented to the company. This report includes the flowcharts, measurements and balances; the critical points encountered; the mental mapping results; priorities set; recommendations and benefits (environmental and economic); the implementation chronogram and monitoring chronogram. The Centre monitors implementation and its results. At this point a summary sheet is annexed to the report and a CP certificate is awarded if the implementation has been carried out appropriately.

Quesillo elaboration at the Telica plant, part of the Guayape Project

Table 1 shows some of the Centre's clients and the financial benefits they have derived from adopting CP.

The Centre's ISO 14001 division was created in 2003. It is involved in ISO 14001 implementation in three enterprises: two African Palm plantations and oil extractors, and a snack factory. ISO implementation is carried out with the help of ENTORNO (the World Business Council representative for Spain) through its consultancy office, Premier Consulting. With the Centre's experience in regard to environmental themes and the support of a Foundation like ENTORNO/Premier Consulting, it has been easy to interest clients in having the Centre carry out ISO 14001 implementation at a reasonable price. When work with these clients is finished, it is not expected that there will be any problem finding new clients.

Progress to date and reflections

A mid-term evaluation of the Centre in early 2002 showed that the Sustainability Fund had accumulated US$ 75,000 within its first 18 months of operation. This amount had increased to $128,687 by 2003. The Sustainability Fund is currently providing funds to cover about 50% of the Centre's operations.

In 2001, the Centre started with two full-time (technical director and administrative assistant) and one part-time (Executive Director) staff. Two more technical staff had been hired by 2003.

Progress has largely been due to three factors:

- a detailed and reasonably realistic implementation strategy;
- highly competent, dynamic, committed and creative staff under the leadership of the technical director;
- flexible support from the donor agency.

The Centre's staff have been capable of reflecting on its directions and activities, and have responded (where possible) to lessons learned.

Training courses

The Centre has understood that for a course to be effective, it must include exercises with case studies. Interactive workshops are needed to train people so they can make a difference in their companies. Seminars are designed to interest new clients in the cleaner production concept, or to inform an enterprise's employees about what will be happening in their company. Training courses are meant to train leaders on a specific methodology, so that they will be able to carry out implementation in their companies.

During the Centre's first years, free courses on product quality and occupational safety themes were offered in order to get companies interested. This proved effective. As soon as the Centre's accomplishments could speak for themselves, the free courses were dropped. The open courses (that is, the ones not contracted by a company but advertised in the newspaper) are time-consuming and the revenue is much lower than that generated by in-plant courses. They are maintained due to their importance in attracting new clients, but their number has been reduced. In general, the Centre's emphasis is now on in-plant courses, paid for and organized by a company exclusively for its employees.

Organizing and delivering courses has been hard on Centre personnel. If courses are to be more efficient and effective, a separate information dissemination and training unit is needed. All events could be planned and coordinated by this department. This would ensure less burnout of personnel, more effective marketing, and perhaps more revenues for the Centre.

In-plant CP demonstration

There have been two basic difficulties in the area of in-plant demonstration. One concerns quantification of inputs and outputs. Most enterprises are not accustomed to documenting their activities. The documentation that is carried out (if any) is not treated as data for decision-making, but merely as recording of statistics. This means the Centre must demonstrate the importance of establishing and using documents appropriately. However, the personnel are not used to quantifying information and normally do not find time for this exercise. The Centre has to find a way to motivate personnel and facilitate matters. This stage of the process is the slowest part.

The Centre provides the enterprise with charts ready to fill in, together with examples of how the data can be used. Nevertheless, the Centre's consultants frequently have to do the quantification themselves. Once data are measured and critical points established, it is easy to continue with documentation because company personnel will have seen its value not in examples, but using their own company information and day-to-day problems. After observing this tendency in several companies, the Centre decided to overlap the implementation stages to make things go faster. As soon as the quantification process is finished, or at least well advanced, the mental maps-feasibility analysis is carried out for the critical points determined so far.

Cream extraction at Lácteos Erika, one of the six small enterprises at the Guayape Project in Olancho

The second difficulty is the perception that the Centre is a magic problem solver. It has required several explanations to make company personnel understand that the Centre is a facilitator, and that for improvements to be continuous they must learn to generate their own recommendations. Not surprisingly, it has been much easier to implement ideas that come from the enterprise personnel rather than from the Centre consultants.

Mental maps have proven an important and effective implementation tool. Most of the time, the reasons behind situations are pretty simple. However, company personnel are too busy putting out fires to address the root of the problem. With the mental maps, the real causes are easily identified and long-standing problems can finally be solved.

Policy development and advocacy

The 1998 feasibility study identified several pieces of Honduran legislation that needed to be reviewed for consistency with CP objectives. Unfortunately the CNP+L-H has not been able to work much in this area for several reasons. The Centre is situated in San Pedro Sula, a highly industrialized region far from the capital city of Tegucigalpa. Travelling to Tegucigalpa requires money and time.

Unless financed by an international organization, the Centre has to cover all its own expenses for participating in environmental policy development. It has been difficult to secure sponsors for the Centre's participation in environmental policy roundtables, for example.

The Centre started with only a technical director, who was responsible for courses, implementation, attending CP meetings and an occasional environmental policy related event. New personnel had no experience with cleaner production. They had to be trained and closely supervised by the technical director.

In retrospect, policy advocacy work might have been facilitated had the Centre (or at least its policy advocacy unit) been located in the capital. Of course, this would have meant additional costs for office rent. However, Tegucigalpa has other advantages that might have offset these costs. It is the country's geographic centre and is connected to all the major road networks. It is also the site of donor agencies' offices. It is arguable that locating the Centre in Tegucigalpa would have offered more opportunities for networking with funding agencies.

Administration of the Centre

The importance of having specialized departments was recognized from the beginning. Working for two years with only a technical director and administrator slowed implementation time, reduced the number of courses offered and weakened the Centre's outreach activities. Having an additional technical expert in the Centre's third year allowed more rapid implementation and more intensive marketing work. Combined with the convincing results of the demonstration projects, extra technical personnel allowed the Centre to get 17 new projects in its third year.

It has been observed that a technician can carry out three demonstration projects in medium to large companies at a good speed. One more project does not result in a slowdown, but rather in staff burnout. More than four demonstration projects per person definitely slows down the process, as well as burning out the technician.

Regularly upgrading the skills of the Centre's personnel is clearly important. It is therefore critical for the Centre to network actively with other cleaner production centres and explore cost-sharing capacity enhancement programmes for its staff.

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Developing a consistent approach to estimating greenhouse gas emissions for the petroleum industry

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Summary
To achieve meaningful greenhouse gas inventories, it is important for methodologies and the definitions of what will be included in the inventory to be consistent. Guidance for calculating and reporting GHG emissions has been developed by the International Petroleum Industry Environmental Conservation Association (IPIECA), the International Association of Oil and Gas Producers (OGP) and the American Petroleum Institute (API). The IPIECA's Petroleum Industry Guidelines for Reporting Greenhouse Gas Emissions focus on petroleum industry accounting and reporting. API's Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry was developed to provide consistent emission estimation methodologies. A tool for estimating emissions, the SANGEA™ Energy and Emissions Estimating System, is available through API.

Résumé
Pour pouvoir dresser un inventaire sérieux des gaz à effet de serre, il est important qu'il existe des définitions cohérentes de ce qui doit figurer dans cet inventaire et d'employer des méthodes harmonisées. L'IPIECA, l'OGP et l'API ont réalisé un guide pour évaluer et déclarer les émissions de gaz à effet de serre. Cet ouvrage, Petroleum Industry Guidelines for Reporting Greenhouse Gas Emissions, est axé sur la comptabilisation et la diffusion d'informations sur les gaz à effet de serre par l'industrie pétrolière. L'API a par ailleurs produit un recueil, Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry, qui présente des méthodes harmonisées d'estimation des émissions. Enfin, l'API propose également un outil d'évaluation des émissions, le système SANGEA™ (Energy and Emissions Estimating System).

Resumen
Para contar con un inventario importante de gases de efecto invernadero, es necesario tener definiciones consistentes del contenido del inventario y recurrir a metodologías congruentes. IPIECA, OGP y API han elaborado guías para el cálculo y la presentación de informes sobre emisiones de gases de efecto invernadero. La publicación Petroleum Industry Guidelines for Reporting Greenhouse Gas Emissions ("Directrices de la industria petrolera para la presentación de informes sobre emisiones de gases de efecto invernadero") aborda la contabilidad y presentación de informes en la industria petrolera. API publicó el Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry ("Compendio de metodologías para calcular la emisión de gases de efecto invernadero en la industria del gas y del petróleo") con el objetivo de proporcionar metodologías consistentes para el cálculo de emisiones. Asimismo, API ha preparado una herramienta para el cálculo de emisiones, conocida como SANGEA™ (Sistema para el Cálculo de Energía y Emisiones).

Worldwide, petroleum companies are responding to concerns about climate change. An important first step to address the climate change issue is to understand the magnitude of greenhouse gas emissions from petroleum industry operations by creating an emissions inventory. In order to quantify emission sources, emissions estimating methodologies are needed, and the boundaries of the inventory must be defined. At present, several standards/protocols/guidelines are available to define the boundaries and provide methodologies for estimating emissions of greenhouse gases. These standards are broadly applicable to many industries where ownership arrangements are not complex and the majority of greenhouse gas emissions arise from the combustion of commercial fuels and/or the use of electricity. However, the petroleum industry has unique processes and emission sources, as well as unique ownership and operating arrangements, which have driven the development of industry-specific accounting and reporting guidelines and estimating methodologies.

Many companies in the petroleum industry have voluntarily undertaken significant efforts to improve consistency in estimating emissions from their operations. To provide an up-to-date and comprehensive set of methodologies for the industry, the American Petroleum Institute (API) developed the *Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry*. Soon after publication of the API Compendium, a second project was initiated to develop consistent guidelines for accounting and reporting greenhouse gas emissions from petroleum industry. The International Petroleum Industry Environmental Conservation Association (IPIECA), in concert with API and the International Association of Oil and Gas Producers (OGP), led the development of the *Petroleum Industry Guidelines for Reporting Greenhouse Gas Emissions*. In support of these initiatives, an estimating and reporting tool, the SANGEA™ Energy and Emissions Estimating System, has been made available free of charge to enable companies to develop an inventory that is consistent with the Guidelines and utilizes methodologies from the Compendium.

Guidelines for reporting

The International Petroleum Industry Environmental Conservation Association, the International Association of Oil and Gas Producers (OGP) and the American Petroleum Institute have taken the lead in developing petroleum industry guidelines focused specifically on the accounting and reporting of GHG emissions at the facility through the corporate level. The *Petroleum Industry Guidelines for Reporting Greenhouse Gas Emissions* (the Guidelines) were issued in December 2003. They are divided into seven chapters that describe:

1. Petroleum Industry GHG Accounting and Reporting Principles;
2. Setting the Boundaries for GHG Emissions Reporting;
3. Designing an Inventory to Monitor Performance;

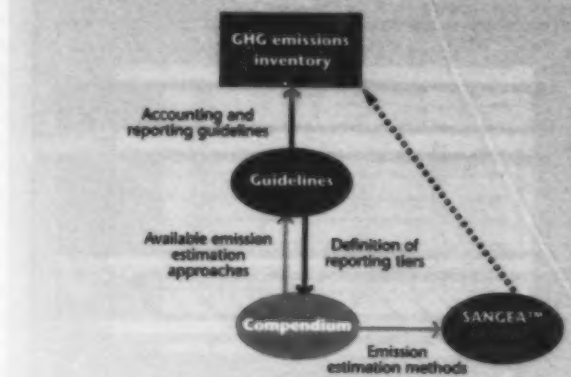
4. Identification of Industry GHG Emissions;
5. Evaluation of Industry GHG Emissions;
6. GHG Emissions Reporting;
7. Inventory Assurance Processes.

The petroleum industry-specific guidelines took as a starting point the *Greenhouse Gas Protocol* developed by the World Resources Institute (WRI) in conjunction with the World Business Council on Sustainable Development (WBCSD). The Guidelines complement other existing protocols for estimating and reporting greenhouse gas emissions by providing information to address the unique situations in the petroleum industry. For example, they provide:

1. industry-specific definitions and examples for determining "operated" and "equity share" emissions;
2. specific guidance on which methodologies from the API Compendium are most appropriate for various groups of emission sources and desired levels of accuracy;
3. guidance on data aggregation within the petroleum industry subsectors;
4. guidance on inclusion of indirect emission sources;
5. options for allocating emissions from combined heat and power plants.

The Guidelines were developed by a focused team of petroleum industry representatives from BP, ChevronTexaco, ExxonMobil and Shell with support from Battelle. Oversight for the team was provided by petroleum companies as well as the sponsoring industry organizations (IPIECA, API and OGP). The first draft of the Guidelines was distributed to members of the petroleum industry, who then participated in a workshop to discuss and incorporate their input. Finally, a consultation draft was broadly distributed to obtain feedback from government agencies and other interested parties.

Figure 1
An approach to consistent emissions estimating



* Emission calculations made following guidelines accounting and reporting procedures and Compendium emission estimation methods

Compendium of methodologies

To assist its members, and as a reference for other interested parties, the American Petroleum Institute first published the *Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry* in April 2001. Publicly available and internal company GHG emission estimation protocols were reviewed for use in developing the Compendium. The resulting document represents a compilation of recognized methodologies for consistent estimation of GHG emissions specific to oil and natural gas industry operations. The initial API development effort focused on emission estimation methods for carbon dioxide (CO_2) and methane (CH_4), as they represent the vast majority of GHG emissions for petroleum industry operations. The Compendium presents and illustrates the use of preferred and alternative calculation approaches for CH_4 and CO_2 for all common emission sources, including combustion, process, fugitive and indirect sources.

In February 2004 API released an updated version of the Compendium, which includes emission factors for nitrous oxide (N_2O), System International (SI) units and additional information received during the comment period. The API Compendium has been reorganized to provide clearer information, and to be consistent with the recently released Guidelines discussed above.

The SANGEA™ System

The task of developing a greenhouse gas emissions inventory for an integrated petroleum company, or for any company with both equity and operated facilities, can be somewhat complex, particularly if the inventory is to allow the company to report based on both equity share and operated emissions and to account for both direct and indirect emissions. To facilitate this task, ChevronTexaco hired a consulting team led by Arthur D. Little, Inc., with software program code development provided by EnVINTA Corporation and auditing expertise provided by PricewaterhouseCoopers. Working closely with ChevronTexaco staff, the team developed an Excel-based tool called the SANGEA™ Energy and Emissions Estimating System. As shown in **Figure 1**, the SANGEA™ System uses methodologies from the API Compendium and enables users to develop an inventory that is consistent with the Guidelines. ChevronTexaco has made the SANGEA™ software available to API, and it can be obtained free of charge.

Developing an inventory: application of the guidelines

Many petroleum companies have been estimating emissions of greenhouse gases for several years using company-specific methodologies and protocols. Now that industry guidance exists as a preliminary step, it is important to understand the distinction between accounting for and reporting of emissions. Greenhouse gas *accounting* concerns the recognition and consolidation of greenhouse gas emissions from operations in which a parent company holds an interest, and linking of the data to specific operations, sites, geographic locations, business processes and owners. Greenhouse gas *reporting* concerns the presentation of greenhouse gas data in formats tailored to various reporting uses.

Many companies have multiple objectives for greenhouse gas reporting, so that the greenhouse gas accounting system must be capable of meeting a range of reporting requirements. Ensuring that data are collected and recorded at a sufficiently disaggregated level, and capable of being consolidated in various forms, will provide companies with maximum flexibility in reporting.

An important consideration companies face in developing an inventory is the decision whether to report:

- all the emissions from facilities over which they have operational control (and none from facilities they do not control);
- emissions based on their share of equity in the facilities; or
- using some other accounting method.

The Guidelines recommend that companies select either the operational control or equity share approach, and that they clearly state which method they use. The Guidelines suggest that companies should consider the purpose of the inventory in deciding whether to report based on operational control or equity share. Because companies often need to provide information for more than one purpose, the Guidelines encourage reporters to develop an inventory that can be used to report both emissions from facilities over which the company has operational control and the company's equity share of emissions.

According to the Guidelines, a company is deemed to have operational control of a facility when the company

has authority to introduce and implement its operational and environmental, health, and safety(EHS) policies at the joint venture.

The Guidelines also provide specific examples of how a company's equity share of emissions should be calculated. Greenhouse gas emissions are apportioned according to the economic interest or benefit derived from a joint venture. In general, the benefit derived from a joint venture is proportional to the working interest or investment share of each partner, and GHG emissions are allocated to the partners according to their interest or investment share.

The next key decision is how to characterize direct and indirect emissions from a facility. Direct emissions are defined as those from sources that are owned or controlled by the reporting company, such as emissions from exhaust stacks or process vents. Indirect emissions are generally considered to be emissions that are a consequence of the activities of the reporting company, but occur from sources owned or controlled by another party. For

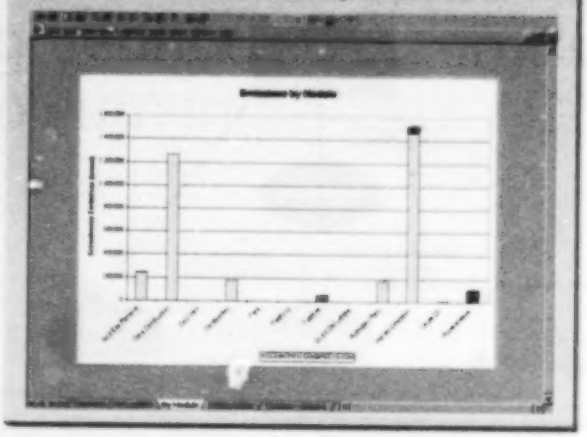
example, indirect emissions could include those from the production of purchased electricity, contract manufacturing, contracted drilling operations and product transport by third parties. The Guidelines provide a rationale for accounting and reporting indirect emissions from energy consumption. An example for the petroleum industry illustrated in the Guidelines is accounting for power plants located within a refinery that export electricity and/or steam to other companies.

Another unique situation for the petroleum industry is contract operations where a petroleum company provides fuel to a contract operator. This occurs in drilling operations, as well as in transportation of crude oil or products. The Guidelines suggest that companies consider accounting for significant contract operations as sources of indirect emissions. Based on the accounting approach described in the Guidelines, provision of fuel to a contract operator should not influence whether the emissions are included as operated or equity share. Since the emissions come from a contracted operation, they are indirect emissions.

Once the inventory accounting approach has been set, and decisions have been made as to what types of reports will be developed and what the data will be used for, the next step is to understand the specific sources included in each facility and what methodology is appropriate to estimate the emissions. The Guidelines provide an overview of the types of methodologies that are appropriate for exploration and production facilities and petroleum and petrochemical refining/manufacturing facilities. These approaches are described for the two types of facilities for various ranges of accuracy, using a tiered approach. Tier A represents the highest level of accuracy. Tier B includes somewhat less rigorous methods, and is therefore likely to be more straightforward and less costly to implement. However, the uncertainty associated with these methods is greater. Finally, for an assessment of emissions where uncertainties of 30-60% are acceptable, Tier C methods may be employed. Each of the Tiers in the Guidelines is linked to appropriate calculational methodologies in the API Compendium.

Specific information about the types of approaches available for estimating emissions is found in the Compendium. For a given facility, and a given range of uncertainty, the specific method used for each source will depend on the information available about that source. For example, the Compendium recommends that the preferred method for estimating emissions from combustion sources is to determine the mass of carbon per mass of fuel and the mass of fuel used. However, the Guidelines and the Compendium recognize that this type of information is not available for all devices in all facilities. Where the preferred information is not available, the Compendium provides alternative methodologies that utilize existing information to develop a reasonable estimate of emissions. For example, in many cases a facility may measure the volume of fuel used and periodically analyze the specific gravity and/or heating value of the fuel. As an alternative to mass based estimates, this information can be used to estimate carbon dioxide emissions from fuel combustion.

Figure 2
SANGEA summary chart



Developing an inventory: methodologies

As described above, the Guidelines provide information on accounting for and reporting to corporate level of greenhouse gas emissions at the facility. A companion publication, the API *Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry*, documents a number of currently recognized calculation techniques and emission factors available for developing GHG emissions inventories for oil and gas industry operations. The Compendium was developed to accomplish the following:

1. assemble an expanse of relevant emission factors for estimating GHG emissions from oil and gas industry activities, based on currently available public documents;
2. outline detailed procedures for conversions between different measurement unit systems, with particular emphasis on implementation of oil and gas industry standards;
3. provide descriptions of the multitude of oil and gas industry operations – from exploration and production through refining to the marketing of products, as well as the transportation of crude oil, natural gas and petroleum products – and the associated emissions sources that should be considered;
4. develop emission inventory examples – based on selected facilities from the various industry segments – to demonstrate the broad applicability of the methodologies.

The Compendium is neither a standard nor a recommended practice for the development of GHG inventories. Rather, it represents a compilation of recognized methodologies for estimating GHG emissions specific to oil and gas industry operations.

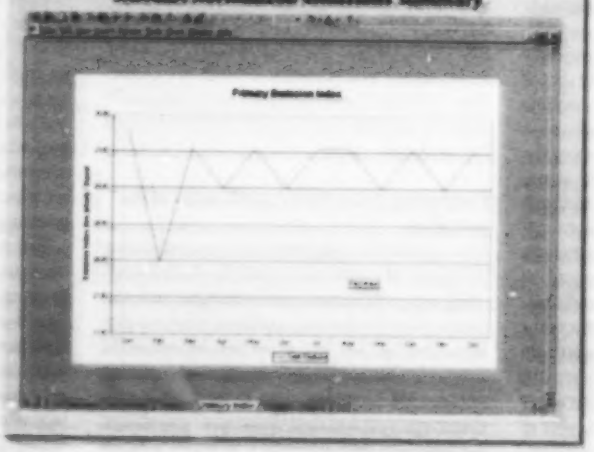
Source classification

The Compendium groups oil and gas industry GHG emission sources into three categories: combustion devices, process emissions and fugitive emissions.

1. Combustion devices include both stationary sources, such as engines, burners, heaters and flares, and fleet-type transportation devices, such as trucks and ships, where these sources are essential to operations (i.e. transportation of material or personnel);
2. Point sources include vents from oil and gas industry units, such as hydrogen plants and glycol dehydrators, that emit CO_2 and/or CH_4. They also include other stationary devices such as storage tanks, loading racks and similar equipment;
3. Non-point sources include fugitive emissions (equipment leaks), emissions from wastewater treatment facilities, and a variety of other emissions generated by waste handling;
4. Non-routine activities, associated with maintenance or emergency operations, also may generate GHG emissions;
5. Indirect emissions are defined as GHG emissions associated with oil and gas company operations, but physically occurring from sites or operations owned or operated by another organization.

The Compendium includes calculation and estimating techniques for determining CO_2, CH_4 and N_2O emissions from all of these sources.

Figure 3
SANGEA normalized emissions summary



Technical considerations

The Compendium provides emission factors from many different references, with many different approaches to defining emissions from the same sources. Careful review of these documents was required to understand the underlying assumptions used in developing the emission factors, and to combine data from multiple references using the reporting conventions selected for the Compendium. Some of the key technical considerations are:

1. standard gas conditions: standard conditions used in the Compendium are 14.7 psia and 60°F (1 atm and 15.6°C);
2. heating value specifications: both higher heating value (HHV) and lower heating value (LHV) are provided to report fuel data in terms of energy and to convert between fuel volume and energy;
3. units: GHG emissions are typically reported in metric tonnes (1 metric tonne = 1000 kg = 2205 lbs.) and emission factors are provided in both English and System International (SI) units of measure.

Other aspects of the Compendium that enhance usability include:

1. tables of fuel properties common to the oil and gas industry;
2. example calculations for each emission estimation method;
3. case studies to illustrate the use of the Compendium and to demonstrate the computational approaches;
4. detailed references to sources of emissions data.

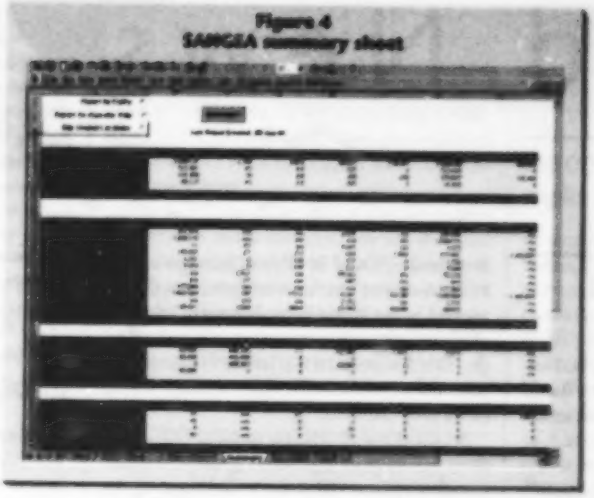
Developing an inventory: the SANGEA™ inventory tool

An electronic data management tool is highly valuable to effectively manage greenhouse gas emissions data following the accounting and reporting approaches contained in the Guidelines, and consistently applying the methodologies from the Compendium.

The SANGEA™ system is a comprehensive energy and emissions management system that can be used to:

1. account for emissions on both an operated and equity share basis;
2. account for and report direct and indirect emissions separately;
3. assess energy utilization and greenhouse gas emissions to determine the major sources;
4. guide energy and greenhouse gas emissions management activities by enabling comparisons of emissions per barrel for similar activities or similar fields;
5. establish the initial baseline for energy utilization and emissions;
6. forecast emissions, both for business as usual and for new energy efficiency projects;
7. set goals for improving energy efficiency and decreasing greenhouse gas emissions;
8. track progress towards interim and final goals;
9. provide an indication of the need to take early action or re-evaluate systems if progress is inadequate;
10. document progress against baseline for potential future crediting;
11. provide a basis for discussions with regulators and other stakeholders about the various parameters that affect energy utilization and greenhouse gas emissions from a mature oilfield.

Figure 4
SANGEA summary sheet



Chevron Texaco directed a team of consultants that developed the SANGEA™ software. It is Excel based, with a Visual Basic add-in containing the calculations, emission factors and macros to help users set up their files. To make sure the SANGEA™ system yields auditable data, PricewaterhouseCoopers recommended a range of controls that were built into the SANGEA™ software.

The SANGEA™ system is comprehensive and modular, so that it can be used to estimate energy utilization and greenhouse gas emissions from all types of petroleum industry sources. Users configure the system for their site, select the applicable modules, and then specify the sources within each module (e.g. turbines, engines and boilers).

Once the SANGEA spreadsheet has been configured, data entry is straightforward, using standard tables for monthly data entry for each source. The input tables can be linked to other data management or accounting systems, such as Excel, J.D. Edwards or SAP.

Users can generate quarterly reports. The system also generates standard charts to show emissions over time, by intensity and as a forecast. As shown in **Figures 2-4**, the summary tables and charts generated by the SANGEA™ software allow the user to analyze the data in many different ways – by location, module or species. Because the SANGEA system uses Microsoft Excel as a basis, the tables can be copied and pasted to other Excel spreadsheets for further manipulation of the data.

Conclusion

A credible, systematic approach to GHG emissions, as embodied in the Petroleum Industry Guidelines and the API Compendium, provides strategic value to the petroleum industry as we address the climate change issue. By furthering the goal of consistent guidance on greenhouse gas emissions accounting, estimating and reporting, our industry improves its credibility and provides a foundation for future cooperative efforts among petroleum industry companies, regulators and other industries to address this important issue.

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Carbon emissions trading begins in Africa

Under the Prototype Carbon Fund (PCF), Durban's eThekwini Municipality and the World Bank have signed the first carbon emission reductions purchase agreement in South Africa. The PCF will purchase 3.8 million tonnes of GMG emission reductions from the project at US$ 3.75 per tonne of carbon dioxide equivalent. This agreement concerns a landfill gas-to-energy project for reducing greenhouse gas emissions. The signing ceremony took place in Cologne, Germany, in June 2004 at the first Carbon Expo, a trade fair for the global carbon market.

The project consists of enhanced collection of landfill gas at three eThekwini landfill sites and the use of this gas to produce electricity. There are two project components: Component One (Mariannhill and La Mercy Landfill) will generate 700,000 tonnes of emission reductions; Component Two (Bisasar Road Landfill) will generate 3,100,000 tonnes. The first component, for which an environmental impact assessment process is nearing completion, should be operational this year. The other component is expected to be fully commissioned next year, pending clearance of social and environmental impact assessments being undertaken in parallel by the Province of KwaZulu-Natal and the World Bank.

The project is intended for the Clean Development Mechanism (CDM) of the Kyoto Protocol, the 1997 international agreement to limit emissions of climate-altering greenhouse gases. The CDM allows industrialized countries and companies with greenhouse gas reduction commitments to purchase some of their required reductions in developing countries. "I think this is a first for the whole African continent, a project of this magnitude, dealing with waste," said Obed Mlaba, Mayor of Durban. "The example we are setting in Durban, working with the World Bank to deal with landfill, is a huge innovation. We are turning dirt and garbage into raw material that we could grow wealth from."

The electricity produced by the project will be fed into the municipal grid, replacing electricity the eThekwini Municipality has been purchasing from other suppliers. Methane and CO_2 are the greenhouse gases targeted by the project. It should result in increased capture of landfill gas nominally composed of 50% methane, the majority of which would otherwise be progressively released to the atmosphere. "This project is indicative of the potential of landfill gas to energy projects throughout the developing world," explained Ken Newcombe, World Bank fund manager for the PCF. "A carbon market intelligence study just released by the World Bank shows that one-sixth of all the carbon finance projects involve land fill gas. This demonstrates that carbon finance has the potential to revolutionize waste management in developing countries."

An additional 20 cents per tonne of CO_2 equivalent will be paid for additional social benefits aimed at poverty reduction and addressing the needs of poor and disadvantaged people in Durban. Payment is conditional upon World Bank approval of the design and implementation of the social implementation plan, as well as commissioning of Component Two. The project will be implemented by the Department of Cleansing and Solid Waste (DSW), eThekwini's municipal solid waste department.

For more information, see prototypecarbonfund.org, or contact: Anita Gordon, Tel: +44 7709 415 253 or +1 202 473 1799, E-mail: agordon @worldbank.org; or Sergio Jellinek, Tel: +1 202 294 6232, E-mail: sjellinek@worldbank.org. ◆

European countries present their national allocation plans for CO_2 emission allowances

The European Commission has accepted eight national allocation plans for CO_2 emission allowances. Plans from five countries (Denmark, Ireland, the Netherlands, Slovenia and Sweden) have been accepted unconditionally. Another three, from Austria, Germany and the United Kingdom, have been approved on condition that technical changes are carried out. These changes will make the plans automatically acceptable, without requiring a second assessment by the Commission.

National allocation plans outline the number of CO_2 emission allowances Member States intend to allocate to energy-intensive industrial plants, so that they can participate in emissions trading from January 2005. The decision concerns more than 5000 plants out of an estimated 12,000 in the European Union. These plants will receive over 40% of the total number of expected allowances.

The EU emissions trading scheme will ensure that GHG emissions in the energy and industry sectors are cut at the least cost to the economy. It will also help the EU and Member States meet their emission targets under the Kyoto Protocol. As Environment Commissioner Margot Wallström said: "Today's decision is a crucial step… it clears the way for almost half of the plants which will be part of the Pan European emissions trading system. The decision shows that we are serious about our climate change policy, and that we can start emissions trading the first of January next year as planned."

For more information, see: http://europa.eu.int/comm/environment/climat/emission.htm. ◆

Asian Development Bank and WRI initiate programme to make transport and mobility sustainable

The Asian Development Bank (ADB) and the World Resources Institute (WRI) have launched a programme aimed at enhancing the environmental sustainability of transport and mobility throughout Asia. Called "Partnership for Sustainable Urban Transport in Asia" (PSUTA), it asks EMBARQ – the WRI Center for Transport and the Environment (www.embarq.wri.org) to: review existing experiences and capacities with respect to sustainable transport in Asia; draw up a set of key indicators for three Asian cities; and develop a strategic framework that can be used to develop medium-term sustainable transport strategies.

Funded by the Swedish International Development Cooperation Agency (SIDA), PSUTA is an important part of the programme of the Clean Air Initiative for Asian Cities for 2004 (www.cleanairnet.org/caiasia). "ADB feels that the emphasis placed by EMBARQ on the development of quantitative indicators for sustainable transport is most appropriate for the situation in Asian cities," says Charles Melhuish, ADB's lead transport sector specialist. "So far, very few cities in Asia have been able to formulate policies that are based on a true reflection of the economic costs of air pollution and congestion."

Under the auspices of the partnership, EMBARQ will conduct case studies in three representative cities across Asia. The first two are Hanoi in Viet Nam and Xian in China. Discussions on the choice of the third city are still going on.

The project's first stage involves the development of key indicators of sustainable urban transport throughout Asia. These indicators will be the foundation of case studies emphasizing a quantitative analysis of factors that affect access to transportation, traffic safety and air quality. The case studies will consist of a critical review of baseline data, as well as recommendations on the institutional arrangements and organizational and technological capacity necessary for sustainable urban transport planning in each city.

In the final stage, the partnership will put forward a strategic framework to help cities throughout the region develop an integrated sustainable transport plan for their particular transport situation. "Addressing sustainable transport in the rapidly emerging economies of Asia today simply makes sense if cities hope to avoid the air pollution, traffic congestion and sprawl that have

plagued industrialized countries over the past century," says Dr. Lee Schipper, EMBARQ's research director. "This project presents forward-thinking city governments with the opportunity to get it right as they develop what will soon be the largest transport markets on the planet." Established in 2002 with the support of the Shell Foundation, EMBARQ -The World Resources Institute Center for Transport and the Environment acts as a catalyst for socially, financially and environmentally sound solutions to urban transport problems. It is currently engaged in sustainable transport planning projects in Mexico City and Shanghai, two of the world's largest cities, which have a population of 18 and 15 million people, respectively.

For more information, contact: Adlai J. Amor, Media Director, World Resources Institute (WRI), 10 G. Street, NE, Washington, DC 22203, USA, E-mail: aamor@wri.org. ◆

Mediterranean freshwater threatened

Tourism is damaging freshwater in the Mediterranean basin, while growing water demand for golf courses, hotels and aquaparks will further strain resources, says the environmental group WWF in its recent report *Freshwater and Tourism in the Mediterranean*. A hotel visitor uses on average one-third more water than a local inhabitant. Annual water consumption by a golf course is equivalent to that of a city of 12,000 inhabitants.

"The tourism industry depends on water, and at the moment it is destroying the very resource it needs," said Holger Schmid of WWF's Mediterranean freshwater programme. The damage includes pollution, shrinking of coastal wetlands that are tourist attractions (and havens for endangered species of animals and plants) and tapping of non-renewable groundwater in some regions. The problem is compounded by the fact the peak summer season for tourists coincides with the period when agricultural irrigation needs are greatest.

The number of tourists heading for Mediterranean coastlines is expected to be between 235 and 355 million per year by 2025, or roughly double 1990 levels. On Spain's Costa Brava, a favourite destination for visitors from Northern Europe, the population of 27 urban areas jumps from 150,000 in winter to 1.1 million in summer, causing water demand to surge. On Cyprus, where water resources are already very tight, eight golf courses are under construction.

WWF says local authorities tend to tackle the booming demand for water by increasing supply, which is not sustainable in the long term. Governments are forced to look for increasingly drastic and costly measures to obtain large quantities of water in arid regions. WWF cites a Euro 3.8-billion (US$ 4.58 billion) Spanish plan to divert water from the Ebro River in the fertile north to the dry southeast.

The WWF report contains a long list of ways that tourists, hotels and governments could cut water consumption, from turning off the tap while shaving to choosing drought-resistant native plants for landscaping.

For more information, see: www.panda.org/downloads/europe/medpotourismreportfinal_ofnc.pdf. ◆

Generating energy from rapeseed in the UK

The world's first commercial venture to generate electricity from rapeseed is planned in northern England. Production is set to begin in July of next year. The pilot power plant at Great Driffield, Yorkshire, will burn oil extracted from rapeseed grown by local farmers, generating an initial 1 megawatt of electricity (enough to power 1000 homes). If successful, the scheme will be extended to several former collieries that already have turbines capable of producing electricity and direct access to the national power grid. Rapeseed, whose bright yellow flowers are part of the spring landscape, is being used across Europe to make "biodiesel", which is added to petroleum-based fuels. However, this will be the first time the crop is harnessed commercially for electricity.

The Swiss-based agrochemicals group Syngenta is providing seed for the project. Farmers will sign a contract to furnish harvested crops to Springdale Energy, a local firm, which will run the power plant. The electricity generated will be sold on to SmartestEnergy, an independent energy trader that is part of Japan's Marubeni group. The programme involves an initial 4000 hectares of crops. Andrew Coker, a spokesman for Syngenta, said the project was the first of its kind. However, he noted that there are some non-commercial schemes in operation, including a subsidized rapeseed power plant in the Reichstag, the German Parliament building.

Until now, schemes using "green" or renewable sources of fuel for electricity have focused on burning straw or biomass crops, such as willow coppice. Governments around the world are under pressure to provide sustainable energy sources to meet their commitments under the Kyoto Protocol. In the United Kingdom this requires 3-5% of electricity to be generated from renewable sources by 2010.

For more information, see www.syngenta.com. ◆

European forum on CSR makes recommendations

At the end of a 20-month European Commission forum, business leaders have agreed that social and environmental issues are a key part of modern business, but that corporate social responsibility (CSR) should not be a legal obligation. At the forum's half-way point, whether principles should be mandatory or voluntary was the main bone of contention between business, trade unions and NGOs.

The forum's report, *European Multistakeholder Forum on CSR – Final Results and Recommendations*, identifies barriers to the wide diffusion of CSR, especially in the case of small and medium enterprises (SMEs). These include scarcity of information and support, the "steep learning curve" facing any company that wants to take account of social and environmental concerns, and the unfamiliar language often used by CSR proponents.

Nine recommendations are made, ranging from the establishment of a web site for all interested parties to including CSR in the curriculum of business schools and universities. In addition, companies should be encouraged to report on their CSR experiences and make this information freely available. EU Enterprise Commissioner Erkki Liikanen, who said the report's conclusions are in line with Commission thinking, added that "it is also healthy that the report points to the boundaries of the CSR concept and to the limits of what it can achieve. CSR is only one instrument among others to achieve sustainable development outcomes." To this end, he said, CSR policies should be integrated with broader efforts to promote economic, social and environmental progress. The responsibility for this cannot just be left with businesses, but should also fall to public authorities.

Forum members have suggested a review meeting in two years, which would focus on putting the recommendations into practice. The European Commission will issue a communication on CSR before the end of this year. In September it will also begin a campaign intended to boost awareness among SMEs.

For more information, see: www.europa.eu.int/comm/enterprise/csr/documents/29062004/EMSF_final_report.pdf. ◆

Industry Updates

Indian industry is becoming greener

The World Resources Institute (WRI) and the Sohrabji Godrej Green Business Centre of the Confederation of Indian Industry (CII) recently agreed to collaborate on projects to advance sustainable enterprises in India. This agreement was announced during the Green Power 2004 Conference in Mumbai, India, organized by the CII, the United States Agency for International Development and ICICI Bank. "With India's rapid emergence in the global economy, we are pleased to partner with the country's premier industry association in harnessing technology innovation, entrepreneurship, and markets to achieve secure and sustainable growth," said Dr. David Jhirad, WRI's vice president for science and research. "Indian and US industry can start implementing energy and environmental solutions that enhance security, achieve climate stability, and eradicate poverty."

Under the agreement, the CII and WRI will set up a programme to assess, measure and report greenhouse gas emissions following the internationally accepted Greenhouse Gas Protocol developed by WRI and the World Business Council for Sustainable Development (WBCSD). CII and WRI will also help expand markets for renewable electric power, promote sustainable enterprises and build public-private partnerships to attract significant investment in green technology, following WRI's New Ventures model.

"We are pleased to collaborate with the World Resources Institute, given its experience and expertise in working with businesses in lessening their environmental impact and ensuring long-term sustainability," said S. Raghupathy, Senior Director and Head of the CII Godrej Green Business Center. "In partnership with WRI, we look forward to being Asia's leading institute for sustainable business and technology solutions."

For more information, see www.ciibc.org. ◆

Industrial pollution is decreasing in the UK

Improved regulation and more stringent fines have helped curb industrial pollution in the United Kingdom. The UK's Environment Agency reports that 613 cases of serious pollution were caused by industry in 2003, a 12% drop compared with the previous year. The farming and waste management sectors were singled out for the progress they have made. "Our risk-based approach to regulation, developed with business, is working," says chief executive Barbara Young, in the agency's annual *Spotlight on Business* report (www.environment-agency.gov.uk/spotlight). "But fines for environmental offences are still far too low."

Average fines were little changed at around £8400 (US$ 15,068), although the heftiest was £232,000 (US$ 416,000), the largest-ever fine for illegal waste management in the UK. However, the waste management sector reduced cases of serious pollution by about 25%. Personal liability for environmental pollution has increased; 11 company directors were fined in 2003. The main repeat offenders were utility companies, which were prosecuted for letting sewage pollute lakes or streams. Water industry pollution incidents rose by around 25% compared with 2002. The construction industry was responsible for 3% of pollution incidents, or 80,000 tonnes of waste annually. This amount is increasing with regeneration works, the Agency reported.

Greenhouse gas and nitrogen oxide emissions both increased, by 5 and 9%, due to increased burning of coal for power generation. There was less oil-based pollution than in previous years.

For more information, see www.environment-agency.gov.uk. ◆

European chemical industry launches technology platform on sustainable chemistry

The European Union's chemical and biotechnology industries have joined forces to promote "sustainable and competitive chemistry". While the EU's chemical industry accounts for 28% of the global chemical trade, this share is 4% lower than a decade ago. CEFIC, the European chemical industry association, and the biotech association EuropaBIO, with the support of the European Commission, have launched a European technology platform on sustainable chemistry. Its purpose is to increase investment in research and innovation and to boost European competitiveness in this sector.

The platform brings together industry, research centres, financial institutions and regulatory authorities at the European level to create a strategic research agenda for the sector. Issues to be addressed include three key technology areas for Europe: industrial biotechnology; materials technology, reaction and process design; and cross-cutting issues including the environment, health and safety, education and skills, research infrastructures and access to risk capital.

"Research is the primary source of innovation in the knowledge-intensive chemical industry and is driving the sector forward," says European Research Commissioner Philippe Busquin. "The European chemical industry has an impressive track record of developing new products and manufacturing processes, but the challenge is to improve the transformation of laboratory ideas into new sustainable products and services to boost EU competitiveness. The EU chemical sector only spends 1.9% of its sales on R&D, less than the United States' 2.5% and Japan's 3%. The new platform will facilitate the establishment of public-private partnerships to address the barriers to innovation and encourage the industry to invest more in research to overcome these challenges and improve the industry's competitiveness." Europe's trade in chemicals grew from €14 billion in 1990 to €42 billion in 2002, with some 25,000 enterprises employing 1.7 million people. To sustain this growth, however, it is vital for the industry to find a balance between long-term, technology-driven and short-term, market-driven research.

Three strategic technology areas have been identified for European innovation: industrial (white) biotechnology, materials technology, and reaction and process design. These technology areas have great potential to transform the chemical industry and to create opportunities for new European enterprises. In addition, due to their many applications, they have the potential to impact significantly on society and promote the development of new sustainable technologies.

The Platform will also address public concerns about effective management of risks to human health and the environment, together with issues that slow down the innovation process (ranging from access to risk capital, stimulation of chemical research careers and facilitation of industry-academia research collaborations, to aspects of public awareness).

One of the main goals is to maintain and strengthen the competitiveness and sustainability of the chemical industry in Europe by providing the technology base for more sustainable chemical production, products and services, as well as improving the infrastructure and financial conditions for innovation.

For more information, see www.cefic-sustech.org/files/Publications/ETP_sustainable_chemistry.pdf. ◆

Paper recycling is increasing in the United States

More than half of the paper used in the United States in 2003 was recovered for recycling. The American Forest and Paper Association (AFPA) says this rate of recovery represents a 69% increase since 1990. Currently 339 pounds (130 kg) of paper is recovered per US citizen, compared with 233 pounds in 1990. The group reports that more than 80% of all paper mills in the US use recov-

ered paper to make their products, with 37% of the raw material for new paper coming from recovered paper.

In 2002 AFPA adopted the goal of recovery of 55% of all paper consumed in the United States by 2012. Through public and private sector partnerships, it has launched educational campaigns to encourage the recovery of more high-quality papers in communities and workplaces.

For more information, see www.afandpa.org/Content/NavigationMenu/Environment_and_Recycling/Recycling/Recycling.htm. ◆

Recycling electronic waste

The decision by computer equipment manufacturer Hewlett Packard to recycle electronic waste worth US$ 1.8 billion by the year 2007 has been greeted positively by environmental groups in the United States. "It is a step in the right direction, but the company has a long way to go," said Ted Smith, Executive Director of Silicon Valley Toxics Coalition (SVTC), a San Jose-based environmental group that conducts research and is an advocate for environmental issues related to high tech industry.

According to Smith, a billion and a half dollars' worth of electronic products and printing supplies translates into roughly 20 million computers to be recycled over the next two and half years. "We have found that most manufacturers couldn't provide recycling data for their US programmes, or their recycling rates were below 2%. What's important is to compare the number of computers and printer supplies recycled by HP compared to the $76 billion in sales last year," he added. "It's encouraging to see that HP has combined recycling goals with concerns about raising social and environmental standards in the supply chain. [But they] can do more harm than good if it is done in an environmentally or socially irresponsible manner."

SVTC, along with some other environmental organizations, has launched the Computer Take-Back Campaign, which recommends that brand owners "take back and recycle computers in a responsible way". The campaign was launched after the 2002 report *Exporting Harm* revealed the devastation experienced by the environment and human health in entire communities caused by pollution from recycling.

For more information, contact: Ted Smith, Silicon Valley Toxics Coalition, Tel: +1 408 287 6707, E-mail: tsmith@svtc.org; or David Wood, Grass Roots Recycling Network, Tel: +1 608 347 7043, E-mail: david@grrn.org. ◆

UNEP Focus

UNEP

Global principles for responsible investment to be developed

UNEP will work with major institutional investors to develop a set of globally recognized principles for responsible investment. The new principles, which will come into force from September 2005, will be designed to protect both the planet and long-term shareholder value by integrating environmental, social and governance concerns into investor and capital market considerations.

The launching of the Responsible Investment Initiative follows a recent meeting of more than 40 investors and fund managers in Paris, organized by the UNEP Finance Initiative (UNEP FI) and hosted by the French company, Groupama Asset Management. Participants proposed a global alliance of investors to guide responsible investment best practice.

Klaus Toepfer, UNEP's Executive Director, stresses that the time is ripe to develop principles for adopting best practice in investment decisions being made around the world: "We believe the investor community is now ready for similar principles to assist with the complex process of responsible investment that meets investor expectations."

The global public and private investor community has a duty to protect long-term asset values. It is therefore a key factor in bringing environmental, social and governance disciplines to the heart of capital market considerations. As Toepfer points out, most investors still see environment and social issues as mid- to long-term issues with little relevance today. Sir Graeme Davies, Chairman of the Universities Superannuation Scheme Ltd., the UK's third largest pension fund, emphasizes that "Pension funds have liabilities which last several decades, so it's inevitable that the serious social and environmental issues which the UN system seeks to address will increasingly become material investment issues as well."

Michael Hölz of Deutsche Bank, the chair of the UNEP Finance Initiative, adds that "UNEP FI is the largest and oldest public private partnership between the UN and the financial sector, with 226 member companies worldwide. As chair of this Initiative, Deutsche Bank firmly believes in the potential of public-private partnerships to develop and ensure governance, environmental and social performance. The results of UNEP FI's Asset Management Working Group, which form the basis for this announcement, are an example of the success of this network."

For more information, contact: Robert Bisset, UNEP Spokesperson in Europe, Tel: +33 1 4437 7613, Mobile: +33 6 2272 5842, E-mail: robert.bisset@unep.fr.

For information about the UNEP Finance Initiative, contact: Jacob Malthouse, Tel: +41 22 917 8268, Mobile: +41 79 707 6932, E-mail: jacob.malthouse@unep.ch. ◆

UNEP opens Brazil office

The opening of a UNEP Office in Brazil is part of efforts to strengthen the delivery of programmes at the regional and sub-regional levels, in line with decisions taken by the Governing Council. The new office, inaugurated in April, will focus on issues including cleaner and greener energy, early warning and assessment, and emergency response to natural disasters.

"The inauguration of this new office in Brazil marks a significant development in our organization's activities in Latin America and the Caribbean and will boost our abilities to deliver sustainable development to the continent as a whole," says Klaus Toepfer, Executive Director of UNEP. "It should also be mentioned that Brazil is one of the world leaders in the area of biomass-based renewable energy and is one of the nations with a rich and important source of genetic diversity."

The new office will help UNEP respond more effectively to the Johannesburg Plan of Implementation with respect to developing new and coordinated approaches and mechanisms for achieving sustainable development, focusing on emerging themes of local and sub-regional interest. It will also play an important role in achieving the Millennium Development Goals, especially regarding environmental sustainability and the integration of sustainable development principles into country policies and programmes to help reverse the loss of environmental resources.

UNEP's Brazil office will work closely with the Ministry of the Environment, the Ministry for the Cities, and the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) in implementing its programmes.

It will also contribute to the process of horizontal cooperation and integration of environmental

agendas currently under development by the MERCOSUR group of countries (Argentina, Brazil, Paraguay, Uruguay) and associated members Chile and Bolivia.

For more information, contact: Rody Onate, Information Officer, UNEP Regional Office for Latin America and the Caribbean, Tel: +55 5202 4841, Fax: +55 5202 0950, E-mail: rody.onate @pnuma.org. ◆

UNEP-Tongji Institute offers new annual course

In July, 36 participants from 25 Asian and Pacific countries – from Afghanistan to Palau – took part in a new leadership programme offered by the UNEP-Tongji Institute for Environment and Sustainable Development at Tongji University in Shanghai. The seven-day course, to be offered annually, will help develop Masters level courses at the Institute.

As part of a teaching consortium created by the Institute, the leadership course is run by a faculty drawn from a dozen universities and educational bodies in the region. Most faculty members are members of the university consortium and provide their teaching input on a voluntary basis, as they expect to learn from one another's approaches and the improvisations the course will demand. Participants, identified as having leadership potential, are drawn from government agencies, community and activist organizations, the private sector, educational bodies and UN agencies.

Klaus Toepfer, UNEP's Executive Director, says that "With China's double-digit economic growth and the commitments in its current, Tenth Five-Year plan to address industrial pollution, cleaner production, sustainable urban development, environmental protection within agriculture, institutional strengthening and transboundary issues, the timing and setting for the first course is ideal." Course architect and UNEP Regional Director Surendra Shrestha emphasizes that "the course has been designed for our future leaders, integrating different perspectives and expertise through a consortium of universities which share a common commitment to sustainability."

The President of Tongji University, Professor Wan Gang, thanked UNEP for the partnership: "This is another step in realizing our vision of hosting a top collaborative research, technical and managerial training facility for the developing countries of this region; one which contributes significantly to UNEP's global and regional environmental assessments as well as to the environmental dimensions of China's major development projects."

In addition to Tongji University, which serves as its hub, the regional consortium includes New South Wales-Wollongong University and Griffith University in Australia, the Nanyang Technological University in Singapore, Yale University in the United States and the Asian Institute of Technology. The Thai Environmental and Community Development Association (or "Magic Eyes"), an NGO in Thailand, and the Hanns Seidel Foundation office in Jakarta also provide support.

The Leadership Programme on Environment and Sustainable Development outcomes will be used by UNEP as contributions to the UN International Decade for Education for Sustainable Development, which begins next year.

For more information, see www.rrcap.unep.org/uneptongji or contact: Tim Higham, Regional Information Officer, UNEP, Bangkok, Tel: +66 2 288 21 27, E-mail: higham@un.org; or Dr. May Li, Deputy Director, International Office, Tongji University, Tel: +86 21 659 82612, E-mail: may@mail.tongji.edu.cn. ◆

UNEP Division of Technology, Industry and Economics (DTIE) HIGHLIGHTS

UNEP project will help restore Iraq's marshlands

UNEP has launched a project to restore the environment and provide clean drinking water in Iraq's marshlands. This project will be implemented by UNEP DTIE. Years of neglect and mismanagement have brought about the marshlands' severe deterioration. Damaged by the construction of dams on the Tigris and Euphrates, they were drained by the previous Iraqi regime. In 2001 UNEP alerted the world to the crisis in this region when it released satellite images showing that 90% of the marshlands had been lost. By 2003 another 3% (325 km²) had disappeared. Experts feared that the marshlands would cease to exist by 2008.

Last year the people living in this region began to open floodgates and breach embankments to bring water back. By April 2004, around one-fifth of the marshes (some 3000 km²) had been re-flooded. The challenge now is to initiate sustainable development in the region and provide clean water and sanitation services to up to 85,000 people.

The project is funded by the Japanese government. Klaus Toepfer, UNEP's Executive Director, says: "I am delighted that the Japanese government has stepped in to support a new beginning for the Marshlands and the Marsh Arabs. Half the world's wetlands have been lost in the past 100 years. I am sure that the lessons learnt during this project will provide important clues on how to resuscitate other lost and degraded wetlands elsewhere on the globe."

Monique Barbut, Director of UNEP DTIE, adds: "We will be putting together, in close cooperation with the relevant Iraqi ministries, a 10-person team of local and international experts… We hope to begin field studies and pilot water treatment projects towards the end of the year."

For more information, contact: Robert Bisset, Spokesperson for Europe, Tel: 33 1 4437 7613, Mobile: 33 6 2272 5842, E-mail: robert.bisset@unep.fr. For press releases, reports and satellite images, see www.grid.unep.ch/activities/sustainable/tigris/index.php. ◆

Environmental performance guidelines drafted for the financial services sector

Companies, institutions, organizations and representatives of civil society, as well as individuals, have been asked for contributions to the Financial Services Sector Supplement (Environmental Performance) being developed by the Global Reporting Initiative (GRI) and the UNEP Finance Initiative (UNEP FI). In September 2003 an international working group was convened to work on a pilot version of the supplement – a set of globally applicable indicators to be used (in conjunction with the GRI Guidelines) to address the environmental impacts of financial sector products and services. These indicators will complement the existing GRI Financial Services Sector Supplement (Social Performance).

Working group members come from 19 leading institutions, representing financial and non-financial sectors. It is co-chaired by one industry and one non-industry member. The group has met three times to review previous work on environmental performance indicators and to develop draft indicators. It is assisted by an Observer Group providing peer review and additional input. Since November, work on the indicators has been supported by Arthur D. Little Ltd.

Fifteen draft indicators have been released for public comment (www.unepfi.net/gri/public). There will be a fourth meeting of the working group in October to review feedback from the public consultation process.

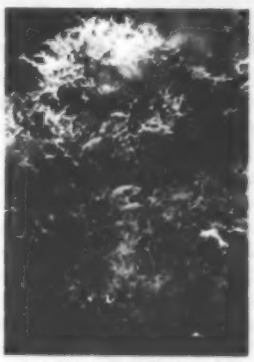
For more information, contact: Niamh O'Sullivan, UNEP FI, (niamh.osullivan@unep.ch), or Sean Gilbert, GRI (gilbert@globalreporting.org). Also see www.unepfi.net/gri. ◆

Capacity building in Africa

Integrated assessment has been highlighted as a priority for the UNEP-UNCTAD (UN Conference on Trade and Development) Capacity Building Task Force for Trade, Environment and Development (CBTF). Training workshops will be part of a series of capacity building activities. The Training Workshop on Integrated Assessment for African Countries, held at UNEP Headquarters in Nairobi, Kenya, in July, targeted

Cold water coral reefs a focus of WED 2004

Saving the world's seas and oceans was the theme of World Environment Day 2004, which was hosted by Barcelona, Spain. This year's WED theme, "Wanted! Seas and Oceans – Dead or Alive?" reflects UNEP's activities on the marine environment and sustainable coastal livelihoods. UNEP released the findings of a report on cold water coral reefs around the world, *Cold-Water Coral Reefs: Out of Sight – No Longer Out of Mind.* The report includes information about cold water coral reefs in various parts of the world. Found at temperatures of 4-13°C, these reefs are usually at depths of 200-1000 metres. However, they can occur in water as shallow as 40 metres or as deep as 6300 metres. Cold water corals thrive in waters off the coasts of more than 40 countries, including Spain, Surinam and the Seychelles. Until recently, it was popularly believed that cold water corals were largely confined to waters in the northern hemisphere (e.g. off Canada, Scandinavia and the British Isles).



Lophelia is the dominant deepwater colonial coral in the North Atlantic

The report demonstrates UNEP's focus on marine protection as a theme for WED 2004. United Nations Secretary-General Kofi Annan said in a message: "Less than two years ago, at the World Summit on Sustainable Development, governments committed to time-bound goals to end unsustainable fishing practices, restore depleted fish stocks, establish a regular global assessment of the marine environment, and create a representative network of marine protected areas. This last goal, to be achieved by 2012, is particularly important. Less than half of one per cent of marine habitats are protected – compared with 11.5% of global land area. Yet studies show that protecting critical marine habitats, such as warm- and cold-water coral reefs, seagrass beds and mangroves, can dramatically increase fish size and quantity, with obvious benefits to large-scale commercial as well as local fisheries."

Klaus Toepfer, UNEP's Ex-ecutive Director, added that during the last four years "the world has adopted a number of internationally agreed development targets, including the Millennium Development Goals and the Johannesburg Plan of Implementation. We have a blueprint for a sustainable future. The challenge is in the implementation. Protecting the marine environment is an essential part of the solution – for food security, for health and for the livelihoods of the billions who depend to one degree or another on the sea. However, protecting the marine environment also means addressing human activities on land, which is where 80% of marine pollution originates."

World Environment Day is observed in more than 120 countries. It was established by the UN General Assembly in 1972 to mark the opening of the Stockholm Conference on the Human Environment. Another resolution adopted by the General Assembly at that time led to the creation of UNEP.

For more information, see www.unep.org/wed/2004. Also see www.barcelona2004. org for the Universal Forum of Cultures in Barcelona.

UNEP asks for photo competition entries

World Environment Day was the occasion for announcing UNEP's fourth International Photographic Competition on the Environment. With "Celebrating Diversity" as its theme, the competition will run until 24 October 2004. Sponsored by Canon and several other global companies, it is open to photographers of all nationalities and ages. The winner will receive a Gold Prize of US$ 20,000.

The General category is open to photographers 25 years or over. There are also categories and cash prizes for "Youth" and "Children". The panel of judges, headed by Takeyoshi Tanuma of Japan, will include Sebastião Salgado of Brazil, Raghu Rai of India and Susan Meiselas of the United States, all world-famous photographers. The awards ceremony will take place in Japan in March 2005.

For full details about the competition's rules and regulations, information on how to submit photographs in both hard and electronic formats, and application forms, see www. unep-photo.com.

selected African research and training institutions as well as economic and trade bodies.

The workshop's objective was to train trainers. It was also intended to introduce economic and trade entities in the region to integrated assessment as a tool for identifying the impacts of trade and trade related policies on the environment and development. The workshop was aimed at providing participants with a better understanding of the concept of integrated assessment and an opportunity to discuss the application of this concept in Africa.

For more information, see www.unep.ch/etu. ◆

Stockholm convention enters into force

Persistant organic pollutants (POPs) are among the most dangerous substances ever released to the environment through human activity. For decades they have been responsible for illness and mortality in people and animals. POPs can cause cancer and damage the nervous, reproductive and immune systems. Exposure to them is also associated with an unknown number of birth defects.

The entry into force of the 2001 Stockholm Convention on Persistent Organic Pollutants on May 17 marks the beginning of an international effort to rid the world of polychlorinated biphenyls (PCBs), dioxins, furans, and nine highly dangerous pesticides, all of which are POPs.

"The Stockholm Convention will save lives and protect the natural environment – particularly in the poorest communities and countries – by banning the production and use of some of the most toxic chemicals known to humankind," says Klaus Toepfer, UNEP's Executive Director. "Over the next several years national investments plus donor pledges of hundreds of millions will channel more than 500 million dollars into an overdue and urgently needed initiative to ensure that future generations do not have to live as we do with measurable quantities of these toxic chemicals stored in their bodies."

Besides banning the use of POPs, the treaty focuses on the growing accumulation of unwanted and obsolete stockpiles of pesticides and other products that contain these chemicals. Dump sites and old drums of toxins are leaching chemicals into the soil, poisoning water, wildlife and people. The Convention also requires disposal of PCBs and PCB-containing wastes.

For more information, contact: Michael Williams, UNEP Information Officer in Geneva, Tel: +41 22 917 8242, Mobile: +41 79 409 1528. E-mail: michael.williams@unep.ch. Also see www. pops.int. ◆

Sustainable consumption and production training material on-line

UNEP DTIE, in cooperation with UNEP partner InWEnt, has carried out training workshops at National Cleaner Production Centers worldwide since 2000. Training has focused on the integration of sustainable consumption and cleaner production. It has also covered multilateral environmental agreements (MEAs) and en.ironmental technology assessment. The training package, developed for NCPC directors and other professionals, includes materials for a two-day session on integrating cleaner production and sustainable consumption, with supplementary reading.

For more information, see http://www.uneptie. org/pc/cp/library/training/cdrpack/cpc.htm. ◆

Books & Reports

General

GEO Yearbook 2003

Global Environment Outlook (GEO) is UNEP's flagship publication. *GEO Yearbook 2003* is the first in a new annual series of GEO publications that complement the GEO report. These Yearbooks will highlight significant environmental events and achievements during the year (at the global and regional levels) as well as emerging issues. They will also present indicators of progress towards sustainability. *GEO Yearbook 2003* includes a section on freshwater and its role in realizing internationally agreed development goals. The entire publication can be downloaded at www.unep.org/geo/yearbook.

(2003). UNEP/DEWA (Division of Early Warning and Assessment), PO Box 30552, Nairobi 00100, Kenya, Tel: +254 20 623562; Fax: +254 20 623944; E-mail: geo@unep.org; Internet: www.unep.org/geo/yearbook. GEO Yearbook 2003 can be ordered from Earthprint Ltd., PO Box 119, Stevenage SG1 4TP, UK, Tel.: +44 1438 748 111; Fax: +44 1438 748 844; E-mail: orders@earthprint.com; Internet: www.earthprint.com. Pbk., 76p. ISBN 92-807-2415-0. Also published in French as GEO Annuaire 2003.

World Resources 2002-2004: Decisions for the Earth: Balance, Voice and Power

This is the tenth in the series of biennial World Resources reports. It contains statistics on environmental, social and economic trends in more than 150 countries. The data collected in *World Resources 2002-2004* support the view that better environmental governance is one of the most direct routes to fairer, more sustainable use of natural resources. Results from the Access Initiative (the first attempt to systematically measure governments' performance in providing access to environmental information, decision-making and justice) are presented. UNEP, the UN Development Programme (UNDP), the World Bank and the World Resources Institute collaborate on the World Resources series. The World Resources database is freely available and is searchable online at www.earthtrends.wri.org. The report is available at www.wri.org/wr2002. There is a CD-ROM version.

(2003). Published by the World Resources Institute, 10 G. St., NE, Washington, DC 20002, USA, Tel: +1 202 729 7600; Fax: +1 202 729 7610, Internet: Pbk., 315p. ISBN 1-56973-532-8. World Resources 2002-2004 can be ordered from Earthprint Ltd., PO Box 119, Stevenage SG1 4TP, UK, Tel.: +44 1438 748 111; Fax: +44 1438 748 844; E-mail: orders@earthprint.com; Internet: www.earthprint.com. Also published in Spanish as Recursos Mundiales 2004: Decisiones para la Tierra: Equilibrio, voz y poder.

State of the World 2004: A Worldwatch Institute Report on Progress Toward a Sustainable Society

The 21st edition of *State of the World* is, as the introduction says, "once again a mix of progress, setbacks, and missed steps around the world that are affecting society's environmental and social goals." This year the focus is on consumerism: how people consume, why they do it, and the impacts of their choices. The "consumer class" has around 1.7 billion members – over a quarter of humanity. Not only does the growing appetite for consumer goods threaten the environment. It also makes it increasingly difficult for the world's poor to meet their basic needs.

Linda Starke, ed. (2004). Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, DC 20036, USA, Tel: + 1 202 452 1999; Fax: + 1 202 296 7365; E-mail (media inquiries): sfinkelpearl@worldwatch.org; Internet: www.worldwatch.org. Publications Ordering and Customer Service Center: Worldwatch Institute, PO Box 188, Williamsport, Pennsylvania 17703-9913, USA, Tel: +1 888 544 2303/2076; Fax: +1 570 320 2079; Internet: wwpub@worldwatch.org. Pbk., 245p. ISBN 0-393-32539-3.

Plan B: Rescuing a Planet Under Stress and a Civilization in Trouble

In *Eco-Economy: Building an Economy for the Earth*, published in 2001, Lester R. Brown argued that the economy is part of the environment – and not the other way around. *Plan B* makes the case for urgent restructuring of the world economy before the "environmental bubble economy" bursts. (Plan A is business as usual.) "The scope of *Plan B* has been limited," Brown explains in the Preface, "so that it will be short enough to be read by busy people… the principle policy recommendations – stabilizing population and stabilizing climate – are central to protecting the diversity of life…If we cannot stabilize population and if we cannot stabilize climate, there is not an ecosystem on earth that we can save."

Lester R. Brown (2003). Earth Policy Institute, 1350 Connecticut Ave., NW, Suite 403, Washington, DC 20036, USA, Tel: +1 202 496 9290; Fax: + 1 202 496 9325; E-mail: epi@earth-policy.org; Internet: www.earth-policy.org. Published by W.W. Norton & Co., 500 Fifth Avenue, New York, NY 10110, USA, Tel: +1 212 354 5500, Fax: +1 212 869 0856, Internet: www.wwnorton.com. Pbk., 285p. ISBN: 0-393-32523-7.

Renewable Bioresources: Scope and Modification for Non-Food Applications

This innovatory handbook was produced as part of work aimed at organizing a joint European Masters degree programme on renewable resources. The authors of individual chapters provide overviews of basic issues that need to be addressed with respect to industry's use of renewable materials. While it is impossible to be an expert in chemistry, biology, biochemistry, agricultural sciences, environmental technology and economics – to say nothing of their complicated interconnections – *Renewable Bioresources* is intended to encourage users to go deeper into these subjects and find more specific information.

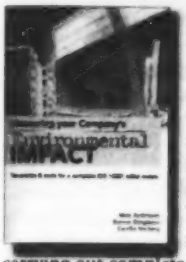
Christian V. Stevens with Roland Verhé, eds. (2004). John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, United Kingdom, Tel: +44 1243 779 777; Fax: +44 1234 770 620; E-mail: cs-books@wiley.co.uk; Internet: www.wiley.com. Pbk., 310p. ISBN 0-470-85447-2. (Also available in hardback.)

Environmental Impact Assessment and Strategic Environmental Assessment: Towards an Integrated Approach

This document provides information and guidance on environmental impact assessment (EIA) and strategic environmental assessment (SEA), with particular application to developing countries and countries whose economies are in transition. It is an update of *Environmental Impact Assessment: Issues, Trends and Practice*, published by UNEP in 1996. As before, this is a companion volume to the UNEP EIA Training Resource Manual, which was issued in an updated and revised edition in 2002. The two documents may be used separately or together.

Hussein Abaza, Ron Bisset and Barry Sadler (2004). UNEP DTIE/ETB (Economics and Trade Branch), 11-13 chemin des Anémones, CH-1219 Geneva, Switzerland, Tel: +41 22 917 82 43; Fax: +41 22 917 80 76; Internet: www.unep.ch/etu. This publication can be ordered from Earthprint Ltd., PO Box 119, Stevenage SG1 4TP, UK, Tel.: +44 1438 748 111; Fax: +44 1438 748 844; E-mail: orders@earthprint.com; Internet: www.earthprint.com. Pbk., 147p. ISBN 92-807-2429-0.

Measuring Your Company's Environmental Impact: Templates and Tools for a Complete ISO 14001 Initial Review



Originally published in Swedish, *Measuring Your Company's Environmental Impact* was designed and written by environmental engineers. It has already been used by consultants and companies in Europe. This step-by-step manual makes available tools for carrying out complete company-wide environmental reviews, as a prerequisite for introducing an environmental management system in accordance with ISO 14001 or the European Eco-Management and Audit Scheme (EMAS). The accompanying CD-ROM includes: a template for an environmental review; an inventory tool to calculate emissions and the impacts of transportation, energy consumption and other activities; and materials for carrying out an environmental failure mode and effects analysis (FMEA).

Matts Zackrisson, Gunnar Bengtsson and Camilla Norberg (2004). Earthscan, 8-12 Camden High St., London, NW1 0JH, United Kingdom, Tel: +44 20 7387 8558; Fax: +44 20 7387 8998; E-mail: earthinfo@earthscan.co.uk; Internet: www.earthscan.co.uk. Pbk. 137p. ISBN 1-84407-054-9.

Raising the Bar: Creating Value with the United Nations Global Compact

Raising the Bar is a comprehensive reference guide produced by an international team of experts. It responds to the need for practical knowledge (tools, case studies, and other types of information and resources) related to the Global Compact's 10 principles. The title refers to the situation businesses face when stakeholders "raise the bar" of expected performance to correspond to universal principles. Published to coincide with the UN Global Compact Leaders Summit in New York in June.

Claude Fussler, Aron Cramer and Sebastian van der Vegt, eds. (2004). Greenleaf Publishing Ltd., Aizlewood Business Centre, Aizlewood's Mill, Nursery Street, Sheffield S3 8GG, UK. Tel: +44 114 282 4375, Fax: +44 114 282 3476, E-mail: info@greenleaf-publishing.com, Internet: www.greenleaf-publishing.com. Pbk., 236p. ISBN 1-874719-8-29.

Corporate Social Opportunity! 7 Steps to Make Corporate Social Responsibility Work for Your Business

Businesses need to be made aware of the opportunities that Corporate Social Responsibility (CSR) provides for developing new products and services, new markets and new business models. *Corporate Social Opportunity!* proposes a practical seven-step process to help business leaders assess CSR's impact on their strategies and operations and to discover opportunities in their own companies. Instead of a "bolt on", CSR can become a valuable "built in".

David Grayson and Adrian Hodges (2004). Greenleaf Publishing (see above). Pbk., ISBN 1874719837. (Also available in hardback.)

Eco-efficiency and Beyond: Towards the Sustainable Enterprise

This collection of papers developed out of two conferences on eco-efficiency held in Düsseldorf in 1998 and 2001. *Eco-efficiency and Beyond* looks at eco-efficiency's past and present and stresses the need for comprehensive uptake of the eco-efficiency concept by business, government and consumers as soon as possible. The challenge of sustainable development will not be met "in slow motion". Policies that offer companies serious incentives for innovative behaviour are urgently needed. The editors are from the Wuppertal (Germany) Institute for Climate, Environment and Energy.

Jan-Dirk Seiler-Hausmann, Christa Liedtke and Ernst Ulrich von Weizsäcker, eds. Greenleaf Publishing (see above). Hbk., 248p. ISBN 1-874719-60-8.

Learning to Talk: Corporate Citizenship and the Development of the UN Global Compact

Learning to Talk is a collection of key writings about the UN Global Compact by some of the leading actors in its development to date. UN Secretary-General Kofi Annan has contributed the Foreword. In 1999 it was Kofi Annan who first proposed such a compact at the Davos World Economic Forum. Officially launched in July 2001, the Global Compact is a set of nine voluntary UN principles for business covering environmental, human rights and labour issues. A tenth principle, on corruption, was added during the UN Global Compact Leaders Summit in New York in June of this year. Publication of *Learning to Talk* coincided with that meeting.

Malcom McIntosh, Sandra Zaddock and Gerog Kell, eds. (2004) Greenleaf Publishing (see above). Hbk., 432p. ISBN 1874719756.

Environmental Policy and Technological Innovation: Why Do Firms Adopt or Reject New Technologies?

This book demonstrates how behavioural models can be applied to understand better why companies adopt clean technologies. There is an analysis of the findings of a case study on companies located in northern Mexico, where inputs required for production are temporarily imported. The conclusions are relevant to industries in other parts of the world with different modes of operation. The author is Senior Advisor in Science and Technology Policy to the Netherlands Organization for Applied Scientific Research (TNO). *Environmental Policy and Technological Innovation* is part of the "New Horizons in the Economics of Innovation" series.

Carlos Montalvo Corral (2002). Edward Elgar Publishing Ltd., Glensanda House, Montpellier Parade, Cheltenham, Glos GL50 1UA, United Kingdom, Tel: +44 1242 226 934; Fax: +44 1242 262 111; E-mail: info@e-elgar.com; Internet: www.e-elgar.uk. Hbk., 304p. ISBN 1-84064-957-7.

The Materiality of Social, Environmental and Corporate Governance Issues to Equity Pricing: 11 Sector Studies by Brokerage House Analysts at the Request of the UNEP Finance Initiative Asset Management Working Group

This report summarizes the results of a project conceived and implemented over 14 months in 2003/4 by a public-private partnership between UNEP and a group of 12 asset management firms. The project's purpose was to explore and document the financial materiality of environmental, social and corporate considerations and criteria as they relate to the investment management of mutual, pension and other institutional funds. Project results show that these funds' owners and managers may be exposing themselves to unnecessary financial risks (and missing out on opportunities) if they do not consider environmental, social and governance criteria in investment procedures.

(2004). UNEP FI (Finance Initiative), International Environment House, 15 chemin des Anémones, CH-1219 Châtelaine, Geneva, Switzerland, Tel: +41 22 917 8178; Fax: +41 22 796 9240, E-mail: fi@unep.ch; Internet: www.unepfi.net. This publication can be ordered from Earthprint Ltd., PO Box 119, Stevenage SG1 4TP, UK, Tel.: +44 1438 748 111; Fax: +44 1438 748 844; E-mail: orders@earthprint.com; Internet: www.earthprint.com. Pbk., 52p.

Values to Value: A Global Dialogue on Sustainable Finance

The UNEP Finance Initiative's *Values to Value* (V2V) report was published just before the UN Global Compact Leaders Summit in June. Designed as a living document, or a "work in progress", it is a ring binder in which papers and conference proceedings are collected. Additional documents in the same format will be made available to users in the future. Thematic sections include "Sustainability Management, Reporting and Indicators", "Civil Society Perspectives on Sustainable Finance", "Asset Management", "Climate Change" and regional initiatives. The accompanying CD-ROM contains the report in pdf format, as well as many other related docu-

ments concerned with finance and sustainability.

(2004). UNEP FI (Finance Initiative), International Environment House, 15 chemin des Anémones, CH-1219 Châtelaine, Geneva, Switzerland, Tel: +41 22 917 8178; Fax: +41 22 796 9240, E-mail: fi@unep.ch; Internet: www.unepfi.net. Values to Value can be ordered from Earthprint Ltd., PO Box 119, Stevenage SG1 4TP, UK, Tel.: +44 1438 748 111; Fax: +44 1438 748 844; E-mail: orders@earthprint.com; Internet: www.earthprint.com. Ring binder.

Energy

Financial Risk Management Instruments for Renewable Energy Projects: Summary Document

Traditional insurance products are gradually becoming more widely available to the renewable energy (RE) sector. However, "institutional inertia" has impeded progress in developing new risk management and financing products. The costs of financing RE projects could be reduced by transferring certain types of risks away from investors and lenders using risk management instruments such as contracts, insurance and reinsurance, alternative risk transfer instruments and credit enhancement products. This report was funded by UNEP's Sustainable Energy Finance Initiative (SEFI) (www.sefi.unep. org). The entire report can be downloaded at www.unteptie.org/energy/qct/fin/index.htm.

(2004). UNEP DTIE, Tour Mirabeau, 39-43 quai André-Citroën, 75739 Paris Cedex 15, France, Tel: +33 1 44 37 14 50; Fax: +33 1 44 37 14 47; E-mail: unep.tie@unep.org; Internet: uneptie.org. This publication can be ordered from Earthprint Ltd., PO Box 119, Stevenage SG1 4TP, UK, Tel.: +44 1438 748 111; Fax: +44 1438 748 844; E-mail: orders@earthprint.com; Internet: www.earthprint.com. Pbk., 47p. ISBN 92-807-2445-2.

Energy Subsidies: Lessons Learned in Assessing their Impact and Designing Policy Reforms

The country case studies collected and analyzed in this report demonstrate the complexity of the use of subsidies. Those that encourage production and use of fossil fuels and other non-renewable forms of energy are generally – but not always – environmentally harmful. Some types of renewables can have negative environmental consequences (e.g. disturbance of regional ecosystems when dams are constructed). Governments should give priority to eliminating subsidies that are both economically costly and environmentally harmful.

(2003). UNEP DTIE/ETB (Economics and Trade Branch), 11-13 chemin des Anémones, CH-1219 Geneva, Switzerland, Tel: +41 22 917 82 43; Fax: +41 22 917 80 76; Internet: www.unep.ch/etu. This publication can be ordered from Earthprint Ltd., PO Box 119, Stevenage SG1 4TP, UK, Tel.: +44 1438 748 111; Fax: +44 1438 748 844; E-mail: orders@earthprint.com; Internet: www.earthprint.com. Pbk., 174p. ISBN 92-807-2277-8. (Also available in hardback.)

Climate

Industry Genius: Inventions and People Protecting the Climate and Fragile Ozone Layer

Industry Genius tells the story of eight companies and two government enterprises whose "inventive genius" is being used to protect the climate and ozone layer. Sometimes the products of this genius are almost accidental. More often, they result from recognition by management and leadership that consumers want green products and that citizens want environmental quality. The Preface was contributed by former astronaut Richard Truly, Director of the US Department of Energy's National Renewable Energy Laboratory; Jacqueline Aloisi de Larderel, UNEP DTIE's Executive Director from 1987 to 2003, wrote the Foreword.

Stephen O. Andersen and Durwood Zaelke (2003). Greenleaf Publishing Ltd., Aizlewood Business Centre, Aizlewood's Mill, Nursery Street, Sheffield S3 8GG, UK, Tel: +44 114 282 4375, Fax: +44 114 282 3476, E-mail: info@greenleaf-publishing.com, Internet: www.greenleaf-publishing.com. Pbk., 192p. ISBN 1-874719-68-3.

Water

Guidelines on Municipal Wastewater Management

This is Version 3 of a set of practical guidelines for decision-makers and professionals on how to plan, design and finance appropriate and environmentally sound municipal wastewater discharge systems. They emphasize the need to link water supply and the provision of household sanitation, wastewater collection, treatment and reuse, cost recovery and reallocation to the natural environment. The Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA) developed the guidelines with WHO, UN-Habitat and the Water Supply and Sanitation Collaborative Council (WSSCC). This document can be downloaded at www.gpa.unep.org. Its contents are shared with the Sanitation Connection Database (www.sanicon.net).

(2004). UNEP/GPA Co-ordination Office, PO Box 16227, 2500 BE The Hague, the Netherlands, Tel: +31 (70) 311 4460; Fax: +31 (70) 345 6648; E-mail: gpa@unep.nl; Internet: www.gpa.unep.org. Pbk., 92p.

Improving Municipal Wastewater Management in Coastal Cities

This is the first version of a training manual for municipal water managers. It was developed with the UNESCO-IHE Institute for Water Education and the UN/DOALAS Train-Sea-Coast Programme. The content is based on the UNEP/WHO/HABITAT/WSSCC guidelines on municipal wastewater management (above). GPA is the only global action programme that specifically addresses the interface between the freshwater and coastal environments. This training manual can be downloaded at www.gpa.unep.org.

(2004) Train-Sea-Coast GPA, c/o UNEP/GPA Coordination Office, PO Box 16227, 2500 BE The Hague, the Netherlands, Tel: +31 (70) 311 4460; Fax: +31 (70) 345 6648; E-mail: tsc-gpa@unep.nl; Internet: www.gpa.unep.org/training. Pbk., 118p.

National/regional

Desk Study on the Environment in Iraq

Desk Study on the Environment in Liberia

These two post-conflict "Desk Studies" follow similar UNEP reports on the Balkans, the Occupied Palestinian Territories and Afghanistan. Between the initiation of the Iraq study in February 2003 and its publication, it was not possible to work in the field, make environmental measurements or contact Iraqui scientists and scientific institutions. The report therefore presents an overview of chronic and war-related environmental issues. Easing the humanitarian situation should have the highest priority (e.g. through restoration of water, power and sanitation networks and ensuring food security). Cleaning up pollution hot spots and dealing with other sources of pollution are also critical. This Desk Study emphasizes that environment should be integrated into reconstruction and development projects.

In Liberia, as in many other countries, an abundance of resources has provoked war and much suffering (a peace agreement was signed in 2003). Liberians have paid a high price for living in a country that is rich in natural resources The most urgent environmental concerns identified in this Desk Study are: increasing access to safe drinking water and sanitation; restoring household and commercial solid waste collection; protecting timber resources; and strengthening the country's environmental management capacity.

(2003, Iraq; 2004, Liberia). UNEP, PO Box

Web Site Highlights

Responsible Care

Canadian Chemical Producers Association (www.ccpa.ca)

European Chemical Industry Council (www.cefic.be)

American Chemistry Council (www.americanchemistry.com)

Synthetic Organic Chemical Manufacturers Association (www.socma.com).

Responsible Care® is a voluntary code of practice for the chemical industry. Created by the Canadian Chemical Producers Association (CCPA) in 1985, the year after the Bhopal tragedy, it focuses on health and safety issues. There is information about Responsible Care and other corporate responsibility initiatives on the web sites of the chemical industry's professional organizations, including those listed above. Individual companies also report regularly on their implementation of Responsible Care (for example, among many others, see www.icca-chem.org/rcreport and www.bayergroupindia.com/res_care.htm).

REACH (Registration, Evaluation and Authorisation of CHemicals)

http://europa.eu.int/comm/environment/chemicals/reach.htm
http://europa.eu.int/eur-lex/en/com/pdf/2003/com2003_0644en.html

The REACH proposal concerning a new EU regulatory framework for chemicals was adopted by the European Commission in 2003. Changes in EU chemicals management policy is likely to have a significant effect beyond the 25 EU Member States. Developments are therefore being watched closely by the chemistry industry and non-EU countries worldwide. (See the articles "A science-based strategy for chemicals control" and "The precautionary principle and the EU chemicals policy" in this issue.) The full text of the REACH proposal is at the second site above.

Mutual acceptance and recognition of data on chemicals

www.oecd.org/document/41/0,2340,en_2649_34379_1890473_1_1_1_1,00.html
http://europa.eu.int/comm/enterprise/chemicals/legislation/glp/data.htm

The same chemical is often being tested and assessed in different countries. Mutual Acceptance of Data (MAD) is the concept that chemical data developed in one country should be acceptable in another country – if the data have been developed in accordance with mutually agreed guidelines and principles. This would mean that data for notifications or registrations only needed to be developed once.

Mutual Acceptance of Data is a programme of the Organisation for Economic Co-operation and Development (OECD), in cooperation with industry, governments and other international organizations. Data generated in the testing of chemicals in a member country (in accordance with OECD Test Guidelines and Principles of Good Laboratory Practice) are accepted in other member countries. The MAD system is open to non-OECD countries. South Africa was the first non-member to participate, beginning in 2002.

The European Union has concluded Mutual Recognition Agreements in the area of Good Laboratory Practice (GLP) with Switzerland, Israel and Japan. By means of the Treaty of the European Economic Area of 13 December 1993, European Regulations and Directives apply to Norway, Liechtenstein and Iceland as well as to EU countries.

Pollutant Release and Transfer and Registers (PRTRs)

www.oecd.org/department/0,2688,en_2649_34411_1_1_1_1_1,00.html
www.oecd.org/document/62/0,2340,en_2649_34411_1913918_1_1_1_1,00.html

The OECD and other international bodies are also involved in efforts to help governments develop databases on releases and transfers of pollutants to the environment. These efforts reflect the growing emphasis on the public's right to know, e.g. in the UN Economic Commission for Europe's Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (adopted 1998, entered into force 2001).

The second site above contains links to PRTR-related web sites in governments and organizations.

30552, Nairobi, Kenya, Tel: +254 2 62134; Fax: +254 2 624489/90; E-mail: cpinfo@unep.org; Internet: www.unep.org. Copies of these reports can be ordered from Earthprint Ltd., PO Box 119, Stevenage SG1 4TP, UK, Tel.: +44 1438 748 111; Fax: +44 1438 748 844; E-mail: orders@earthprint.com; Internet: www.earthprint.com. Pbk., 96p. ISBN 92-1-158628-3 (Iraq); Pbk., 116p. ISBN 92-807-2403-7 (Liberia).

Life Cycle Assessment for Green Productivity: An Asian Perspective

This book is the outcome of a regional survey on life cycle assessment (LCA) commissioned by the Asian Productivity Organization. Case studies were carried out in eight countries (China, India, Indonesia, Japan, Republic of Korea, Malaysia, Singapore and Thailand). These case studies and complementary country reports are collected here. LCA has been applied more widely in Asia since the ISO 14040 standards began to be published in 1997. With its focus on quantitative system-wide environmental inputs, outputs and potential outputs, LCA can enhance Green Productivity (GP) initiatives.

Reginald B.H. Tan, ed. (2003). Asian Productivity Organization (APO), Hirakawa-cho Dai-ichi Seimei Bldg. 2F, 1-2-10, Hirakawa-cho, Chiyoda-ku, Tokyo, 102-0093, Japan, Tel: +81 3 5226 3920, Fax: +81 3 5226 3950, E-mail: apo@apo-tokyo.org, Internet: www.apo-tokyo.org. Pbk., 224p. ISBN 92-833-2348-3.

Policy Implementation and Fisheries Resource Management: Lessons from Senegal

Widespread overfishing is a growing threat to sustainable management of the world's fisheries. Opinions differ concerning the impact of fishing subsidies on the stability of fish stocks. To help meet the need for more information, UNEP supported this study on the implementation of a set of conservation measures aimed at promoting sustainable management in Senegal's fisheries sector. The study recommends restricting access to fisheries through establishing fees and fishing zones and involving local councils. It also suggests improving the enforcement of existing regulations.

(2004). UNEP DTIE/ETB (Economics and Trade Branch), 11-13 chemin des Anémones, CH-1219 Geneva, Switzerland, Tel: +41 22 917 82 43, Fax: +41 22 917 80 76, Internet: www.unep.ch/etu. This publication can be ordered from Earthprint Ltd., PO Box 119, Stevenage SG1 4TP, UK, Tel.: +44 1438 748 111; Fax: +44 1438 748 844; E-mail: orders@earthprint.com; Internet: www.earthprint.com. Pbk., 72p. ISBN 92-807-2436-3.

Chemicals, pollution/ accidents

IPCS Environmental Health Criteria (EHC) 230: Nitrobenzene

Nitrobenzene is a synthetic compound, most of which is used in the manufacture of aniline (a major chemical intermediate that is used to make polyurethanes). Numerous accidental deaths and poisonings in humans due to the ingestion of nitrobenzene have been reported.

The International Programme on Chemical Safety (IPCS) Environmental Health Criteria series provides critical reviews of the potential health and environmental effects of chemicals and combinations of chemicals. They are primarily risk evaluations. Reviews are based on published and unpublished studies. The series is published under the joint sponsorship of UNEP, the International Labour Organisation (ILO) and the World Health Organization (WHO), within the framework of the Inter-Organization Programme for the Sound Management of Chemicals (IOMC). EHS documents are produced in English, with French and Spanish summaries. The series is available from WHO and WHO sales agents.

(2003). Pbk, 130p. ISBN 92-4-157218-3. WHO, Distribution and Sales, CH-1211 Geneva 27, Switzerland. Tel: +41 22 791 2476, Fax: +41 22 791 4857, E-mail: bookorders@who.ch, Internet: www.who.int.

Radioactive Releases in the Environment: Impact and Assessment

Artificial radionuclides have been injected into the environment by nuclear weapons testing and by accidents, notably the Chernobyl reactor accident in 1986. Very low levels are released to the environment in effluent from nuclear power stations and nuclear fuel cycle facilities. Production and use of radionuclides for medical and research purposes also leads to some environmental releases. *Radioactive Releases in the Environment* includes chapters on: general principles for managing radioactive wastes; environmental levels of radionuclides resulting from use of nuclear power in its various forms; and radionuclide releases from other industries. Among expected users are those responsible for providing radiological data or information for legislative and related purposes.

John R. Cooper, Keith Randle and Ranjeet S. Sokhi (2003). John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, United Kingdom, Tel: +44 1243 779 777; Fax: +44 1234 770 620; E-mail: cs-books@wiley.co.uk; Internet: www.wiley.com. Pbk., 473p. ISBN 0471 88924 0. (Also available in hardback.)

THE UNEP DIVISION OF TECHNOLOGY, INDUSTRY AND ECONOMICS

Current uses and development of natural resources, technologies and production processes, as well as urbanization patterns, have negative effects on human health and the environment. This is illustrated by unsustainable use of water, land and energy, air and water pollution, persistent and toxic bio-accumulative chemicals in the food chain, and other industry-related problems.

To have a healthy environment, we need to change how we produce and consume goods and services. This change involves revising and developing economic policies and trade practices, so as to integrate environmental issues in the planning and assessment processes.

UNEP's Division of Technology, Industry and Economics (UNEP DTIE) was created in 1998 to help decision-makers in governments, local authorities and industry develop and adopt policies and practices that:

- are cleaner and safer;
- use natural resources efficiently;
- ensure adequate management of chemicals;
- incorporate environmental costs;
- reduce pollution and risks for humans and the environment.

UNEP DTIE, whose main office is in Paris, is composed of:

◆ **The International Environmental Technology Centre (Osaka)**, which promotes the adoption and use of environmentally sound technologies, with a focus on the environmental management of cities and freshwater basins, in developing countries and countries in transition.

◆ **The Production and Consumption Unit (Paris)**, which fosters the development of cleaner and safer production and consumption patterns that lead to increased efficiency in the use of natural resources and reductions in pollution.

◆ **The Chemicals Unit (Geneva)**, which promotes sustainable development by catalyzing global actions and building national capacities for the sound management of chemicals and the improvement of chemical safety world-wide, with a priority on Persistent Organic Pollutants (POPs) and Prior Informed Consent (PIC, jointly with FAO).

◆ **The Energy and OzonAction Unit (Paris)**, which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition, and promotes good management practices and use of energy, with a focus on atmospheric impacts. The UNEP/RISØ Collaborating Centre on Energy and Environment supports the work of this Unit.

◆ **The Economics and Trade Unit (Geneva)**, which promotes the use and application of assessment and incentive tools for environmental policy, and helps improve the understanding of linkages between trade and environment and the role of financial institutions in promoting sustainable development.

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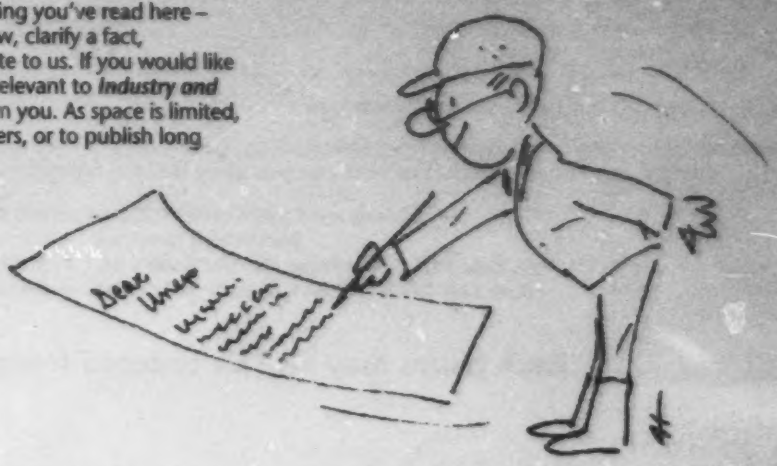

PENULTIMATE ISSUE

Industry and Environment

a publication of the United Nations Environment Programme Division of Technology, Industry and Economics

For over 20 years, the quarterly *Industry and Environment* has provided a forum for exchanging information and experience. Industry managers, government officials, researchers and others active in the field of sustainable industrial development have contributed articles on subjects of broad international interest and specific themes such as retailing, construction, small and medium enterprises, water and development, to name some of the most recent topics.

The next issue of *Industry and Environment* will focus on UNEP's 8th International High-level Seminar on Sustainable Consumption and Production.

That will be the very last issue, as *Industry and Environment* will be discontinued at the end of 2004. Discontinuation of the quarterly coincides with a change in emphasis in the strategy of UNEP's Division of Technology, Industry and Economy. Other DTIE publications will continue to help achieve UNEP's basic goal of sharing practical and technical information about sustainability issues and challenges.

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